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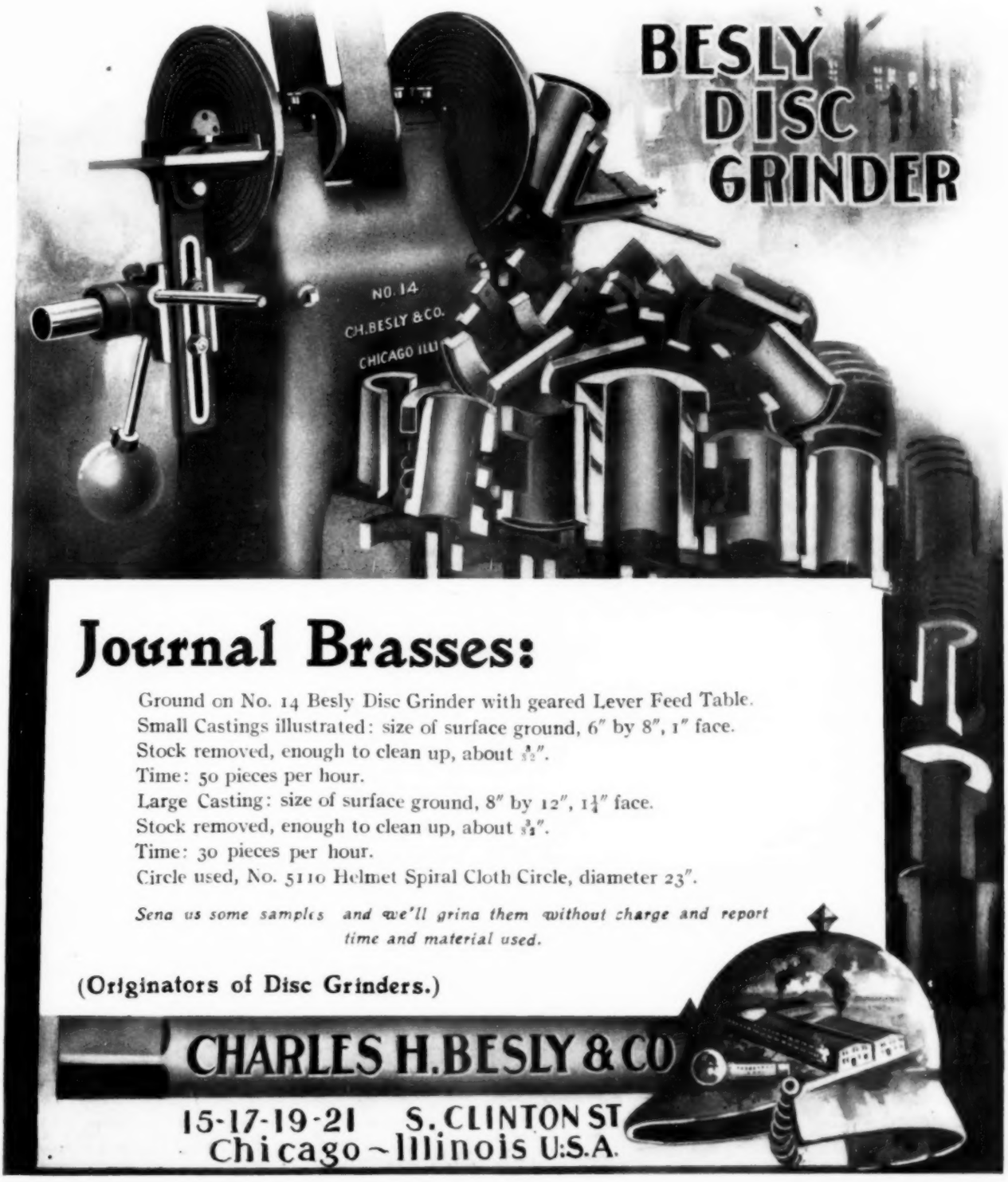

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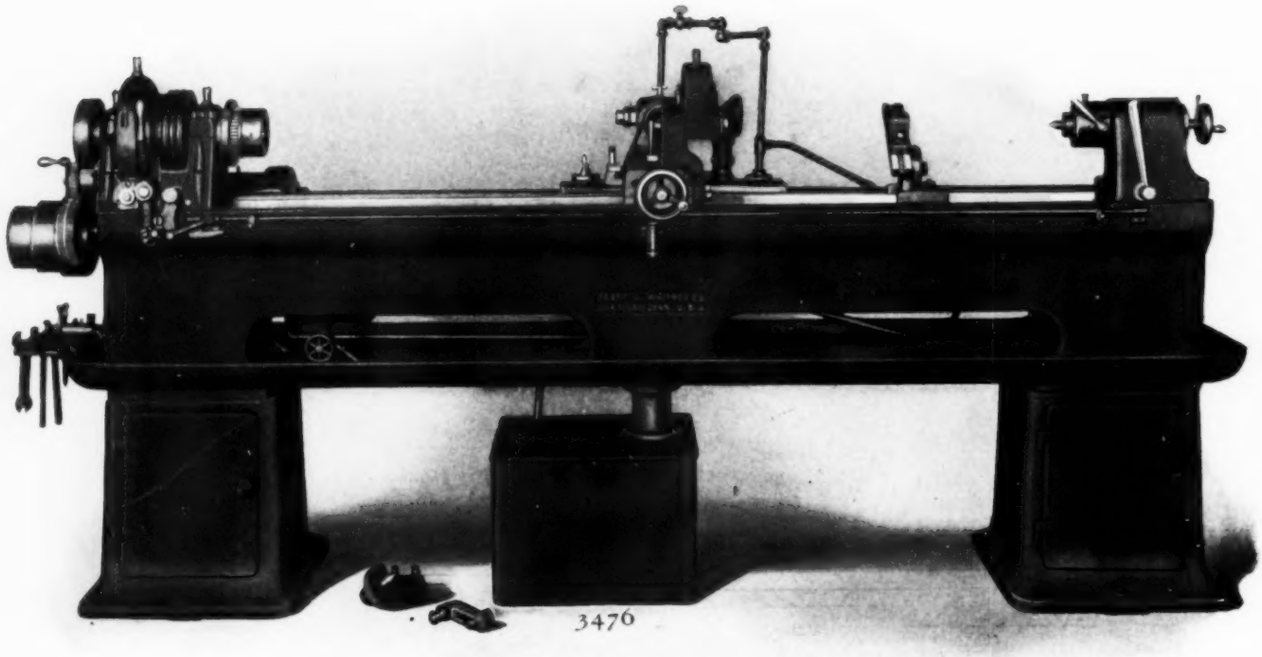

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The Bench Lathe as a Manufacturing Tool*

How the B. C. Ames Dial Gages Are Machined in Bench Lathes and Other Tools and Tested with Special Devices

BY F. A. STANLEY

The dial-measuring gages manufactured by B. C. Ames & Company, Waltham, Mass., are made in several forms as shown in Fig. 1, which illustrates also the mechanism of these instruments. At the center of the group is represented the regular gage head which is fitted with a back plate suitable for attaching to a holder to enable the tool to be used as a test indicator or a measuring device. At the right is shown an upright gage with an adjustable table mounted on a stand on which work may be placed while making accurate measurements. The instrument at the bottom of the engraving is a jaw gage for measuring the diameters of small parts, the thickness of sheet metal, etc. At the top is illustrated the mechanism of the gage as it appears when in position in the case and also when removed bodily with the plate upon which it is mounted. An open case is shown to the left of the jaw gage with only the operating plunger, rack and spring in position.

FIG. 1. THE B. C. AMES DIAL MEASURING GAGES

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Gage Mechanism

The mechanism of these gages is somewhat similar in appearance to a watch movement. The methods of manufacture include many ingenious operations, a number of which are performed in the bench lathe with the aid of attachments and tools of various kinds.

The main plate of these gages, upon which is carried the wheel train for operating the indicating pointer, is a brass disk in which are formed several recesses or depressions to admit the gears. At the center is attached a small bridge under which the pinion for the indicator hand is located, and near the periphery are mounted three brass cocks for receiving the wheel-train pivots. The cocks are located by dowel pins, and, like the central bridge they are secured in place by screws tapped into the main plate. The pinion actuating the hand or pointer in front of the dial cannot be seen in Fig. 1 owing to its position under the bridge; but the arrangement of the operating train and the manner in which it is controlled between the spring-retarded contact plunger and rack and the gear and hair spring at the opposite side, will be obvious upon inspection of the half-tone.

Drilling Jigs

The recessing of the main plate and the boring of the holes for the train pivots are operations for which the bench lathe is best adapted. The screw and dowel-pin holes for bridge and cocks and the holes for locating the plate itself in its case are drilled with jigs of a simple nature and a number of which will be noticed in Fig. 2, which illustrates a sensitive drill with several spindles under which the work is handled in the jigs to advantage.

The general character of the jigs, the arrangement of the clamping devices, etc., will be understood without special explanation. They are simple to manipulate, are accurately constructed and produce accurate results.

Master-plate Operations

Figs. 3 and 4 show a B. C. Ames bench lathe equipped for handling the main plate of the dial-test gage, which plate is about 1¾ inches diameter. For forming the shallow wheel recesses in the plate it is located on the master plate shown in position in Fig. 3 and the tool in the tail spindle brought into action. After a certain recess has been formed in each plate in the lot undergoing operations, the mas-

ter plate is shifted to the second position and the corresponding recess in each plate finished.

The cutting tool which is shown in detail in Fig. 5, has a depression *a* which leaves a small boss at the center of the recess and this is afterward faced off to give the required amount of end shake for the wheel arbor or shaft occupying that position. The tool is shown also at the center of the group, Fig. 6, and needs little description. It may be stated, however, that the cutter *b*, Fig. 5, is for finishing the corner of the bridge which is attached to the center of the gage plate. This bridge, in its original form, is a circular plate which is cut down in the master-plate operation to a narrow rib with concaved sides and rounded edges. This will be seen upon inspection of the different plates on the bench lathe bed in Fig. 3. The recessing cutter, as seen in Fig. 5, has a groove *c* at the back to keep the cutter in position in the holder and an adjusting screw *d* at the rear end; screws *e* and *f* secure the cutter and screw *g* holds the corner-rounding cutter *b*.

Use of the Half-open Tailstock

In Fig. 1 a dial gage plate is shown under the head with the three cocks in place, while the work on the master plate has one attached. Through this piece and the circular plate, pivot holes are to be bored in line, and for this work a center spotter, a drill and reamer are used. One of these tools is shown in place in the holder in the half-open tailstock, and the insuring correct alinement and proper depthing of teeth when the train is assembled in the frame.

A Milling Fixture

Fig. 7 illustrates a bench-lathe fixture for milling the round end and the sides of the cocks, one of which is represented in place with the cutter in operation. This

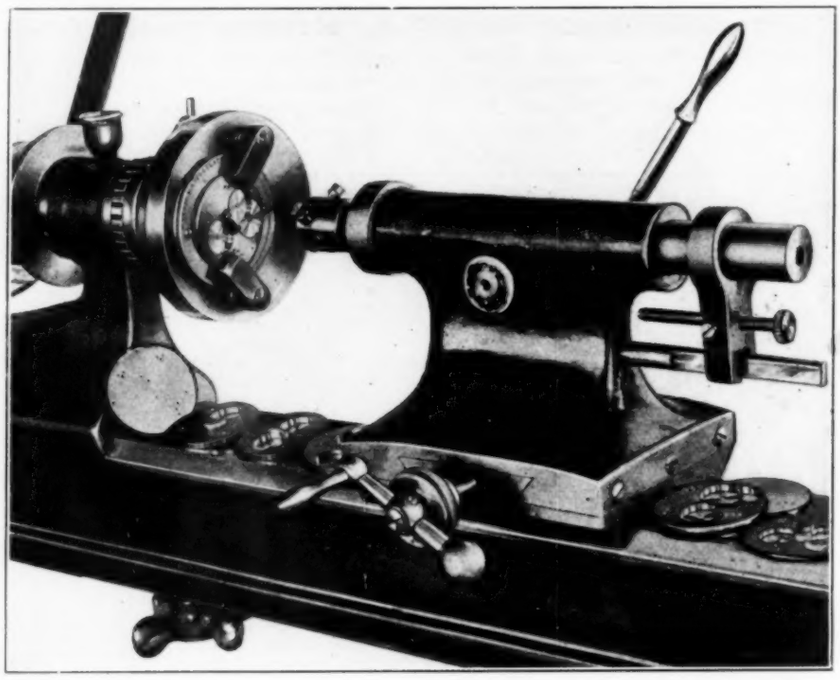


FIG. 3. CUTTING RECESSES IN CAGE PLATES

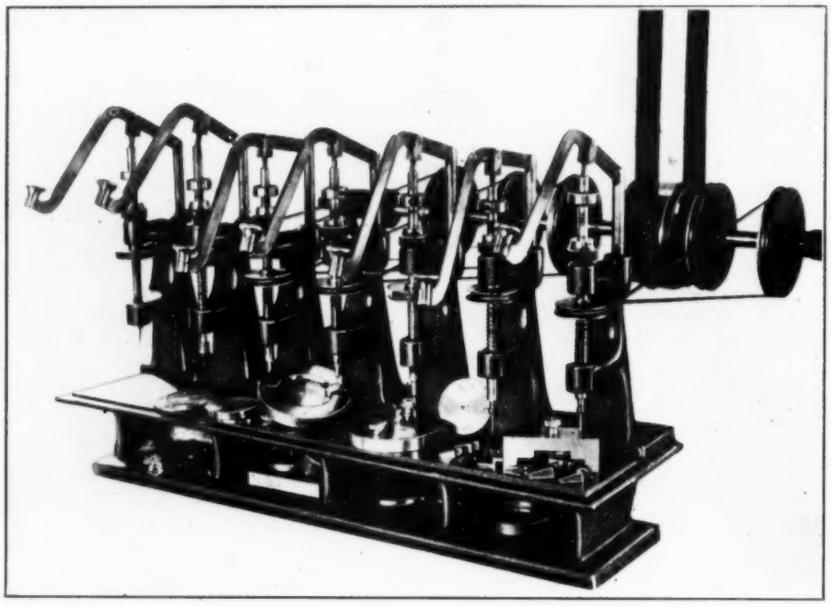


FIG. 2. DRILL JIGS FOR PARTS OF DIAL MEASURING GAGES

other two will be noticed at the right on the bed. The holes for the other members of the train are put through the cocks, bridge and main plate in the same way, the work being correctly located by the master plates and the holes put straight through both brass pieces, thus

device is also shown in the background, in Fig. 6. The upper part of the fixture is pivoted on the base and adapted to swivel between two stops which accurately determine the angle through which it may be operated. When the fixture is swung around against one stop-screw after the latter is properly adjusted, the cross slide screw is turned to feed the work past the cutter which in this operation mills one straight side of the brass piece. The fixture is then swung around on its swivel and the end of the work nicely rounded to the correct radius. When the fixture is swung clear to the back against the other stop screw the cross slide screw is again operated to feed the work past the cutter again for the milling of the opposite side of the cock. The degree of taper desired along the sides of the piece is readily obtainable by means of the adjusting screws in the stops.

A Boring Fixture

A simple boring fixture is shown in Fig. 8, which illustrates the method of boring and finishing the plunger hole in the case for the jaw-measuring gage made by this concern. The face-plate attachment consists of a small angle iron on which the jaw gage case is easily secured, the angle plate being located so that it positions the work correctly for the forming of the hole. A twist drill held on the tail center is put through, then the boring tool held in the manner shown is used. After this has been run through it is followed by a reamer which is also held on the tail center.

Grinding Attachment and Swing Rest

In Fig. 9 is shown a bench-lathe attachment used when grinding small work, pivots, etc. The work holder is self-contained, carrying its own tail center, and being slipped bodily into the head spindle which, of course, is locked to prevent rotation. It will be seen that the grinding is done with the work running between two dead centers.

The steel pieces ground in this device are afterward fitted into brass gears, several of which will be noticed in Fig. 10, which shows the application of the swing rest, or "jeweling" rest, for this class of work. The work is held in the chuck and the opening in each gear made to suit the steel piece to be inserted.

The construction of the Ames swing rest is clearly shown in this engraving and in Fig. 11. It will be noticed that the distance from the lower fulcrum to the curved rest at the top on which the swinging bracket slides, is exactly twice the distance to the tool spindle which is located central with the spindle of the lathe on which it is used. The tool or cutter with which the work is done, is inserted in the taper hole in the end of the spindle and so ground as to cut the form of recess desired, but with its cutting edge at the dead center when not in use. In contact with the yoke which spans the curved surface at the top, will be seen fingers having the same curve, and actuated by a screw at their rear end, having a ball at the end of a neck, which, resting in a hole of the same size in the finger, carries it forward as the screw is turned.

How the Rest is Used

There are three of the fingers to permit the cutting of as many diameters of recess. When used for jeweling, as in watch work, when the finger is brought to a fine line on the curved surface, and a jewel or setting inserted and held in contact between it and the yoke, it naturally follows that the whole diameter of the jewel at this point, permits a cut to be taken equal to half of its diameter or its radius at the cutting edge, or just to fit the piece being set. One or two trials are made for a fine fit and any number of

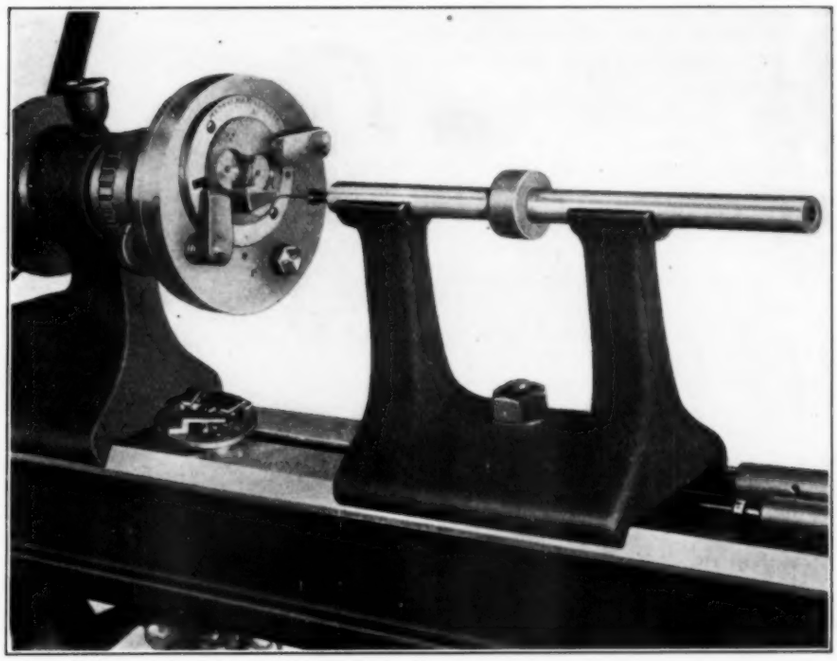


FIG. 4. USING THE HALF-OPEN TAILSTOCK

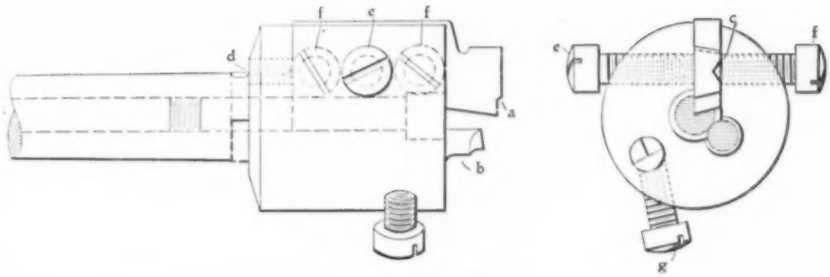


FIG. 5. RECESSING TOOL

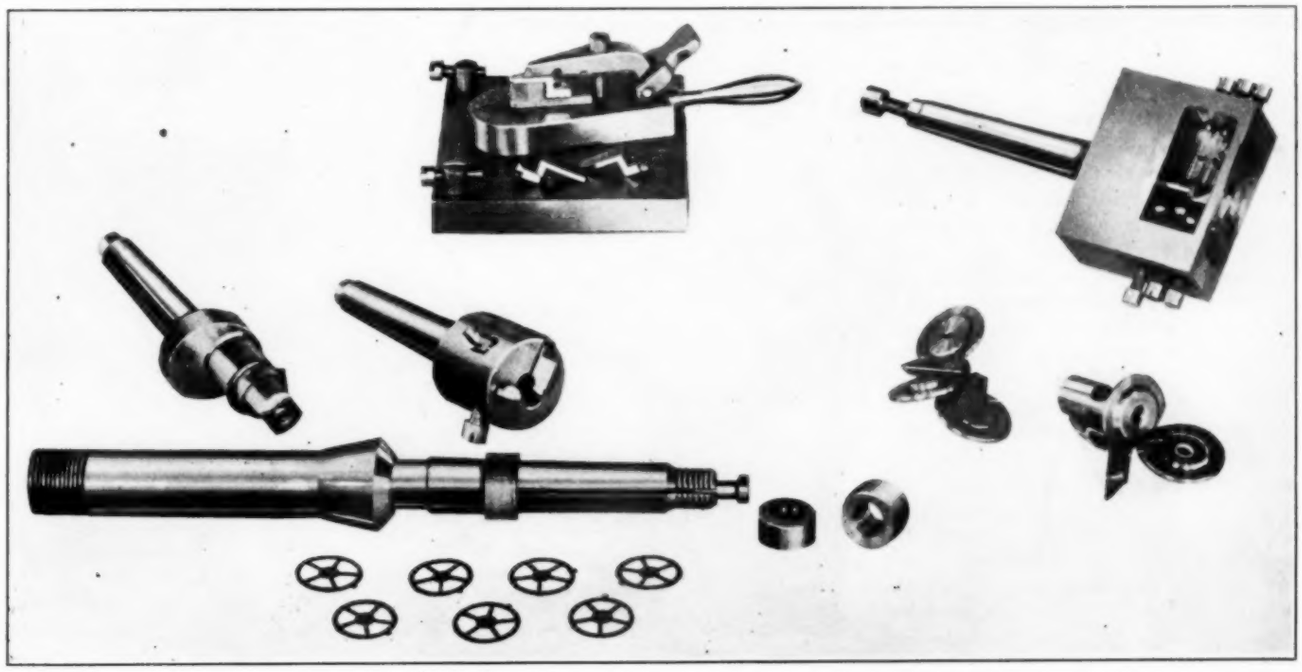


FIG. 6. A GROUP OF BENCH-LATHE APPLIANCES

pieces of varying sizes can then be set without further trial. The piece to be fitted thus constitutes a gage for making its own recess.

In using this attachment as illustrated in Fig. 10, the steel arbor to be fitted in the gear wheel is inserted as shown between the swing rest jaws, and thus positions the cutting tool correctly in precisely the same manner as when the device is used on watch work for a jeweling operation.

The staking operation for holding the gear in place on the steel arbor is performed with the tool shown to the right of the watch lathe in Fig. 10.

A box tool for turning such parts as the steel piece carrying this gear is shown at the right-hand side of the group of tools in Fig. 6. Some extra bushings and cutters used in the box tool are also illustrated in the half-tone.

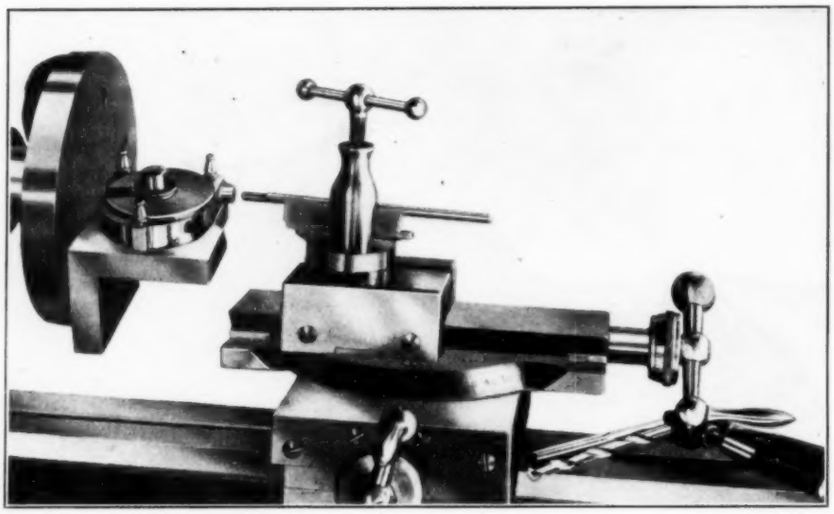


FIG. 8. A BORING FIXTURE

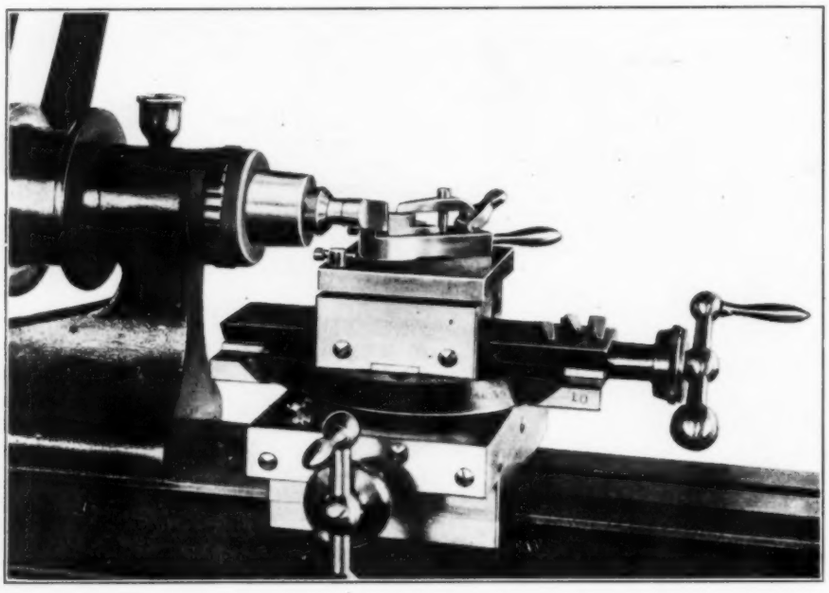


FIG. 7. A BENCH-LATHE MILLING FIXTURE

GEAR CUTTING IN THE BENCH LATHE

One of the most interesting processes in connection with this gage work is the cutting of the gears, which is also done in the bench lathe with the attachment illustrated in Fig. 12. An ingenious arbor is employed for holding the wheels, and its construction will be understood upon inspection of Figs. 6 and 13; it being shown in the foreground of the former cut and in detail in the line engraving. There are five arms in the wheels to be cut with the device, and the hollow arbor is provided with five slots so that the work may be slipped on from the end. The outside of the arbor is ground to fit the inside of the wheel rims; the slots and hole in the center are made large enough to clear the arms and hub. After the arbor is loaded with the wheels over portion *A*, the plug *b* is slipped into the end, the collar *c* slipped on and nut *d* put in place and tightened. The work is then ready to be put into the gear-cutting attachment. Plug *b*, as will be seen, has a center by which the outer end of the arbor is supported as indicated in Fig. 12.

The wheels are made from sheet brass in the sub-press, and in the blanking operation a small lug is left on the rim to be used as a locating medium during a subsequent operation. In placing the wheels on the arbor the lugs are all brought into line and the entire row is then milled away during the cutting of the gear teeth. The collar at *e*, Fig. 13, against which the wheels are clamped, is tightly fitted on the arbor to cover the curved ends of the slots formed by the saw when making the five cuts to admit the arms of the wheels.

The cutter arbor is quite as ingenious in its way as the holding arbor for the work. As illustrated in Figs. 6, 12 and 14 it has an eccentric extension at the outer end to receive a circular fly cutter which can be ground back as it becomes

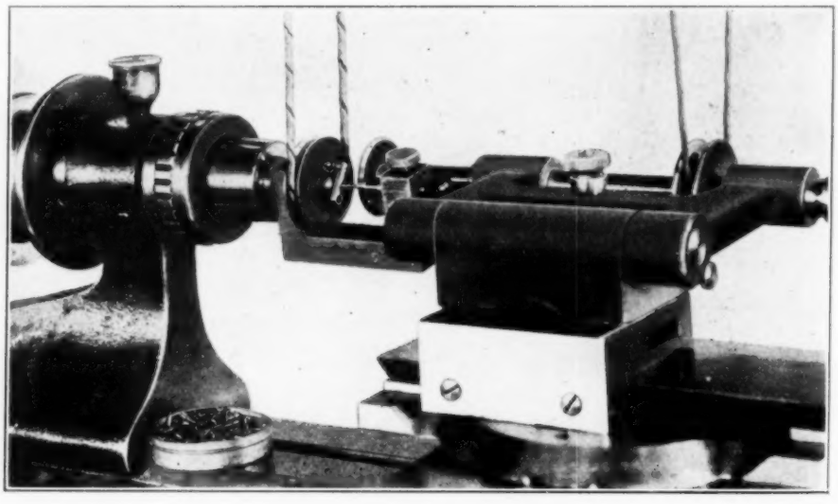


FIG. 9. A GRINDING OPERATION

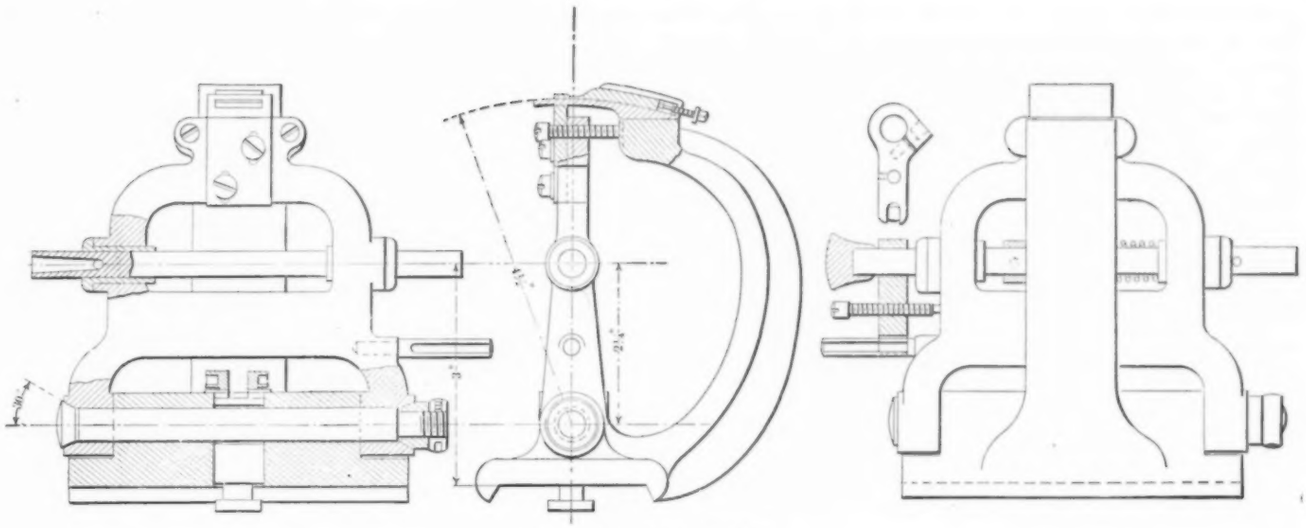


FIG. 11. SWING REST

worn and yet retain its correct form. The cutter is made with the cutting edge somewhat back of the center to provide clearance and can be used through 300 degrees or more before being worn out.

Handling Gage Parts

In connection with the manufacturing operations shown, it may be of interest to refer to some of the processes connected with the finishing and testing of the completed instruments.

In Fig. 15 are illustrated a number of handy wooden trays which are employed at the Ames shop for holding the gage parts while they are progressing through the various assembling operations. The openings in the trays are made quite a little larger than the main plate of the gage and deep enough so that the plate and all the wheels, cocks, etc., for one instrument can be dropped in all ready for assembling in their turn. As the pieces in one tray are assembled, the complete mechanism ready for fitting into its case is placed in another tray, and thus the work is conveniently carried along from one tray to another and without danger of parts being lost or injured.

Testing Devices

Some interesting testing appliances are illustrated in Fig. 16. A gage head ready for inspection is shown at the upper right-hand corner of the engraving. To test it, it is slipped into the micrometer fixture immediately to the left, where it is brought into contact with the end of the micrometer spindle, and the latter is operated to test the instrument through its entire range.

It will be noticed that the thimble of the micrometer is grooved longitudinally at five equidistant points and a detent is so placed as to lightly engage the grooves as the thimble is rotated. Thus the operator in turning the micrometer thimble can tell by the sense of touch, when each advance of 0.005 inch has been made and can keep watch on the movement of the indicator hand to see if it registers correctly in its sweep around the dial.

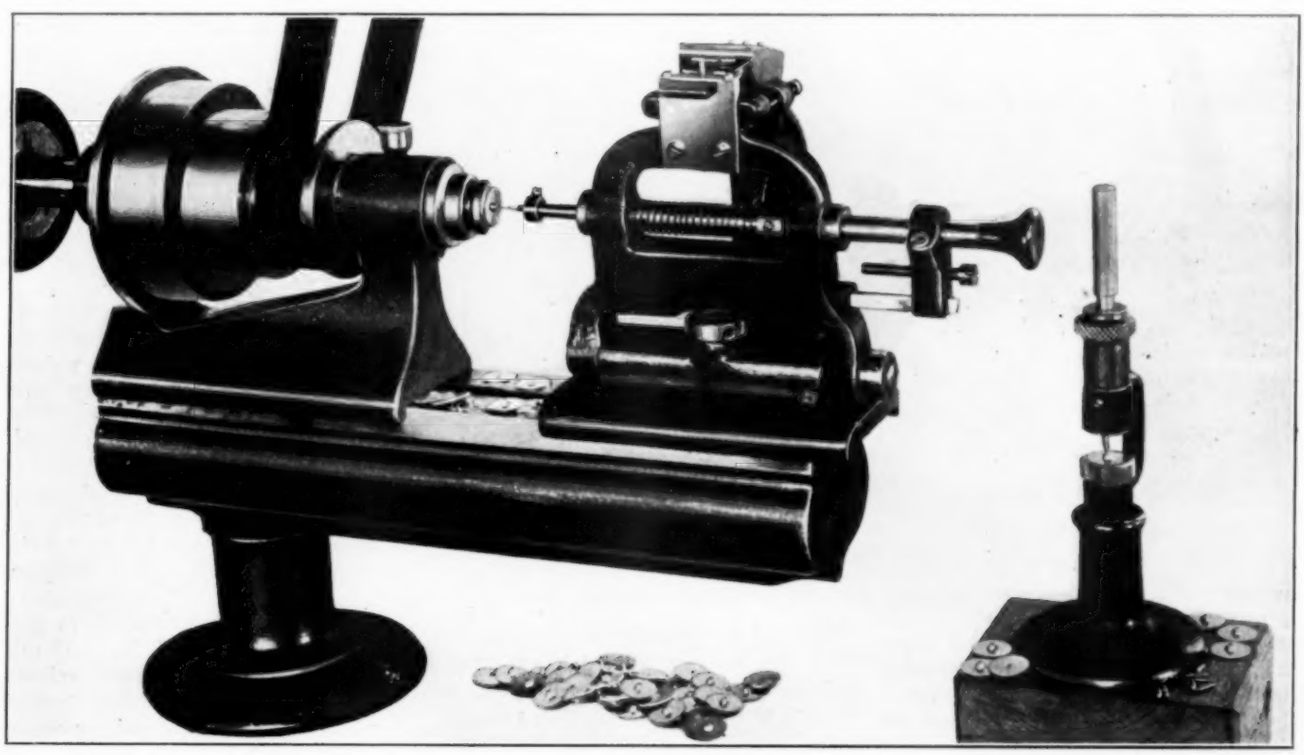


FIG. 10. USING THE SWING REST

The jaw gages of the type shown in Fig. 16 are tested as represented, by standard plugs which are introduced between the measuring jaws. A set of such plugs and a block for holding them are shown in the upper left-hand corner of the illustration.

Trade Opportunities in Chile

By M. de Moreira

Chile, which has suffered so much through the earthquake of 1906, has given the world a fine example of what a nation can accomplish through perseverance, progress and industrial development. In the last three years, $360,000,000 has been invested in new industrial undertakings. Nitrate fields, copper mines, gold, silver, tin and coal deposits have been developed; railways, steamships, cold-storage plants, sawmills, etc., have been built and $10,000,000 is to be spent on the harbor and docks of Valparaiso.

This big field for export, as well as that made up of all countries of the west coast, belongs rightfully to the United States, still it is now in the hands of European countries.

Chile is one of the most progressive countries among the South American republics; its natural wealth is enormous and the exploitation of its mines, though not fully developed, is progressing every day. American capital is invested principally in the copperfields of central Chile, the goldfields of the South and the nitratefields of the north, therefore, giving to our manufacturers a great opportunity to place American machinery on the Chilean market. It is sad to relate, however, that we let these great opportunities pass by and apparently prefer to see Englishmen and Germans take the lead.

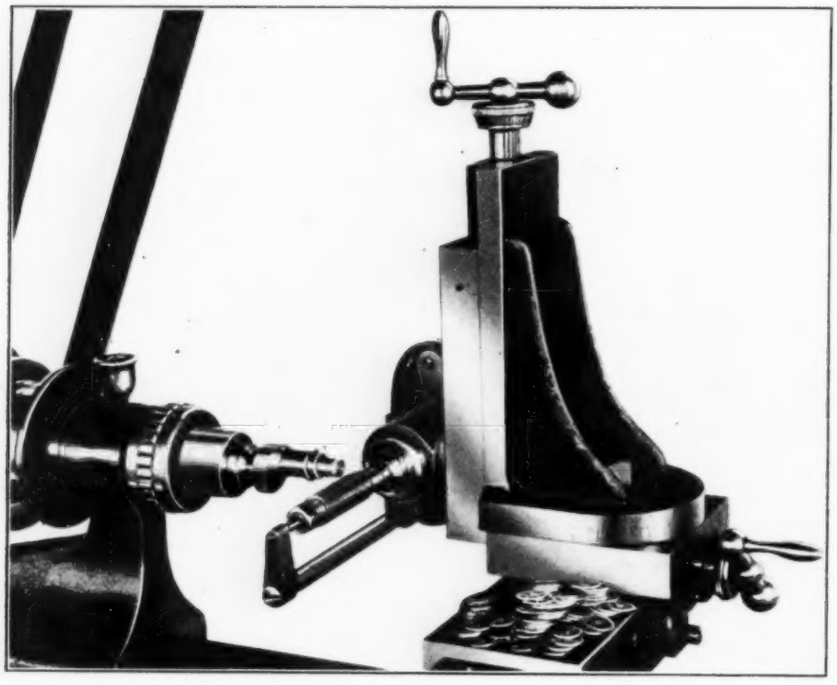


FIG. 12. A GEAR-CUTTING OPERATION

Growth of Chilean Trade

Many of our manufacturers, of course, think that it is not worth while to place their goods before the Chilean buyers, as there is, in their mind, very little business there. They are greatly mistaken. Let me give some statistics which will show that the Chilean market is not to be disdained:

	1906.	1907.	Decrease or Increase.
Imports....	$ 86,759,639	$107,193,877	+$20,434,238
Exports	105,711,811	102,229,456	— 3,482,355
Tot'l trade	$192,471,450	$209,423,333	+$16,951,883

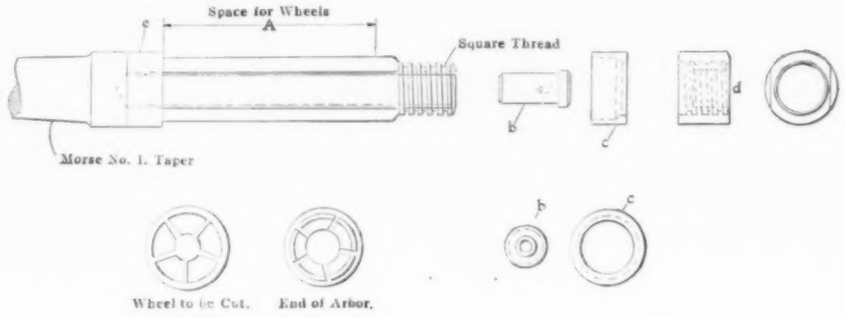


FIG. 13. ARBOR OR QUILL USED WHEN CUTTING TEETH IN WHEELS

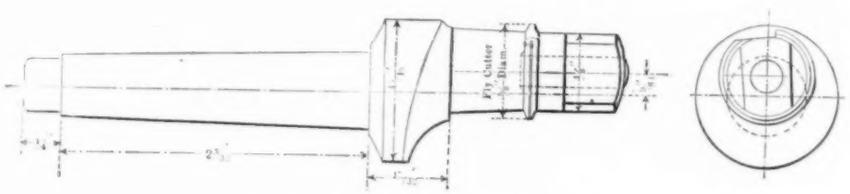


FIG. 14. FLY CUTTER FOR BRASS GEARS

As one will readily see, this table shows a large trade increase over the previous year; unfortunately our manufacturers have very little to congratulate themselves with about it, as the United States comes only fourth in the list of the nations which export goods to Chile. It is interesting to know that out of the figures previously mentioned, machinery and tools imported in Chile in 1906 amounted to $14,646,611 against $17,469,249 in 1907 and that about half of this import belongs to England; the other half is divided between Germany, France, United States and Belgium, the individual amounts decreasing in the order named.

Railroad Development

If this table does not convince the manufacturers, though they say figures talk, facts will probably have more weight. Here are a few: Much has been done toward developing railroads in Chile. The year 1907 saw the completion of several short lines that have opened up important sections not reached by the main lines and now according to reliable information the government has started the line paralleling the coast, from Arica to Puerto Montt. The state railways have lately purchased 60 locomotives, 75 passenger cars and 1200 freight cars. Out of this large purchase for a small railway country, the United States has supplied only 25 locomotives and 60 passenger cars! Ten different lines of railway is the extent of the present Chilean rail trans

FIG. 15. WOODEN TRAYS FOR GAGE PARTS

portation, but these lines are becoming larger every day and need new material and supplies. Once the Isthmian canal is opened and the railway from Valparaiso to the Atlantic coast finished, Chile will be the quickest route from New York to Buenos Ayres, as it will avoid the long detour around the eastern part of Brazil.

Not only has their railroad transportation increased, but their merchant marine as well. The last official statistics give Chile 85 steamers and 90 sailing vessels with a tonnage of 110,000 tons.

After Brazil and Argentine, Chile has the best navy in South America and the Government maintains very good repair shops along the coast. Docks are being built, but unfortunately through our negligence, lack of information or lack of interest, all the steam cranes employed to handle freight at Valparaiso are of English make. The last purchase made was that of two steam cranes at a cost of $90,000.

Are not these facts sufficient to show American manufacturers that their machinery and machinery tools should be known in Chile?

Electrical Installations

Another opportunity that the American manufacturers should not let other nations benefit by, is the electrification of a considerable portion of the lines which are now operated by steam. Coal is obtained in Chile at an excessive cost, being nearly all imported from Cardiff and Australia, and the government naturally is anxious to reduce the cost of operation.

One of the proposed electrical power plants is the transformation of a large steam-power plant at Santiago de Chile into a hydro-electric plant of a capacity of no less than 20,000 horsepower. This plant will furnish light and power for Santiago de Chile and vicinity and will be worked on the same plan as the Sao Paulo Light and Power of Sao Paulo, Brazil, giving to the city a good and up-to-date car system. An electric road of 10 miles in length, connecting Talcahuano with Concepcion is also planned; the power plant of that line is to be of 1500 horsepower and the line will handle both passengers and freight.

Consul A. A. Winslow, of Valparaiso, reported some months ago that the Ger-

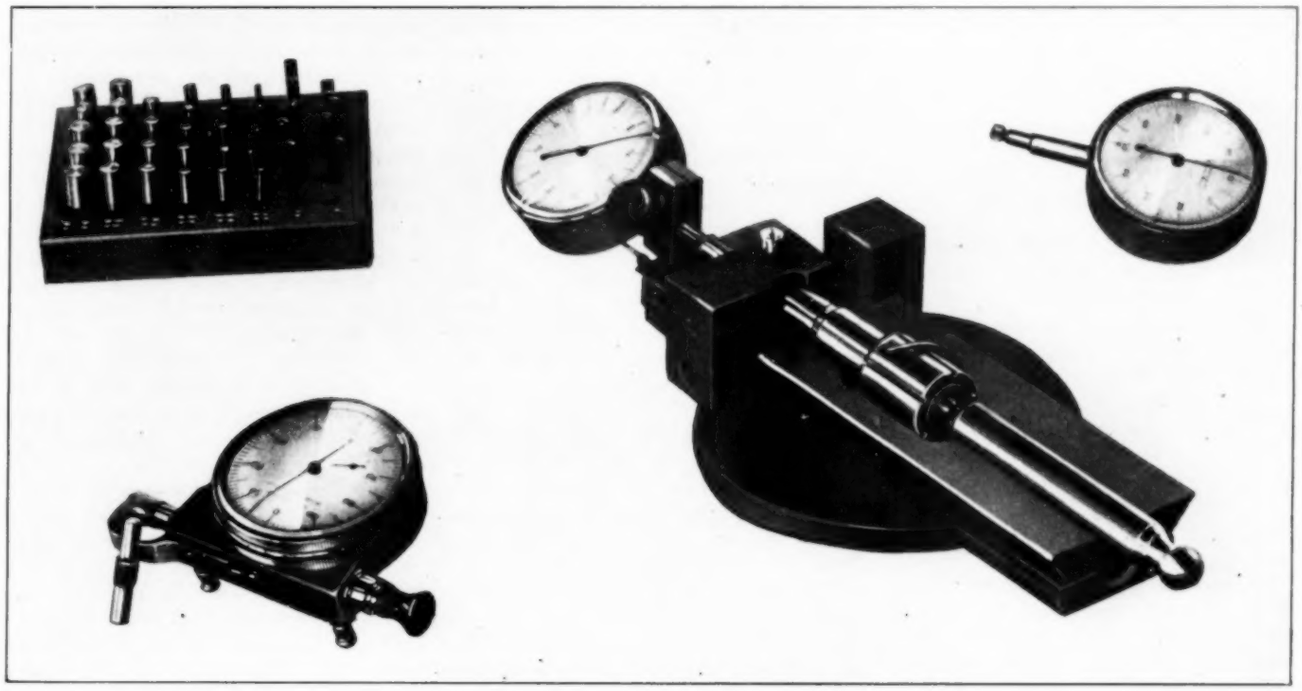


FIG. 16. GAGE TESTING APPLIANCES

man Transatlantic Electric Company has a concession to erect a hydraulic electric-power and lighting plant on the river Maipo, above Santiago, at an estimated cost of $4,015,000, of which $1,295,040 will be for materials and machinery that must be imported.

American manufacturers of mining machinery have certainly everything in their favor to sell their goods in Chile. Though agriculture in Chile offers a wide field, the richest products of the country are derived from its mines, particularly from its immense nitrate deposits.

The Chilean nitrate year, 1907-8, ending March, 1908, shows a total production of nitrate of 4,159,084,858 pounds, which is an increase of over 1,000,000 pounds over the previous year. At the opening of 1907, the nitrate works numbered 121; all are operated by machinery almost exclusively of English make.

One drawback for exporting machinery is that Chile is under a high protection tariff and machinery pays a high import rate; nevertheless it is equally high for all nations and there is no reason why America should not compete with England and Germany.

The economic conditions of Chile make a good showing. After having paid all the expenses of the budget of 1906 as well as the extraordinary expenses caused by the earthquake of August of that year, the financial position on the first of January, 1907, was satisfactory, with a government surplus of $4,000,000.

The Need of a Credit System

The credit system used there is about the same as the one used in Brazil, and American manufacturers can easily make arrangements with the Chilean buyers, so that their drafts could be discounted at once through their own banks.

There is no doubt but that American banks, or agencies for banks, would be of great benefit to American exporters, but thus far American bankers, who seem to be more progressive than their European colleagues, have not taken the trouble to study the situation. They never will either, unless the manufacturers who fill the banks with money group themselves together and demand that banking agencies be opened in South America in order to protect their business interests, and to enable them to investigate the financial standing of the buyers; in short, to allow them to compete favorably as far as credit terms are concerned with England and Germany.

Sizes of Helical Springs without Mathematics

Safe Loads, Deflections, Sizes of Wire, Diameters of Coils and the Number of Coils Can Be Found from These Simple Charts

BY A. T. NICKERSON

Tables of proportions of helical springs are given in some pocket books, but the use of such tabular data is often more or less confusing. The accompanying charts are offered as a quick and accurate means of determining the proportions of helical springs.

The curves of the charts are plotted from Begtrup's well known and generally accepted equations:

$$W = 0.3927\, S\, \frac{d^3}{D-d},$$

$$F = 8\, P\, \frac{(D-d)^3}{E\, d^4},$$

where:

W = The safe working load, in pounds,
F = The deflection of one coil in inches,
S = The ultimate tensile strength of the material (here taken as 60,000 pounds),
D = The outside diameter of the coils in inches,
d = The diameter of the wire in inches,
P = The load in pounds, and
E = The torsional modulus of elasticity (here taken as 12,000,000).

The expression $(D - d)$ equals the mean diameter of the coil.

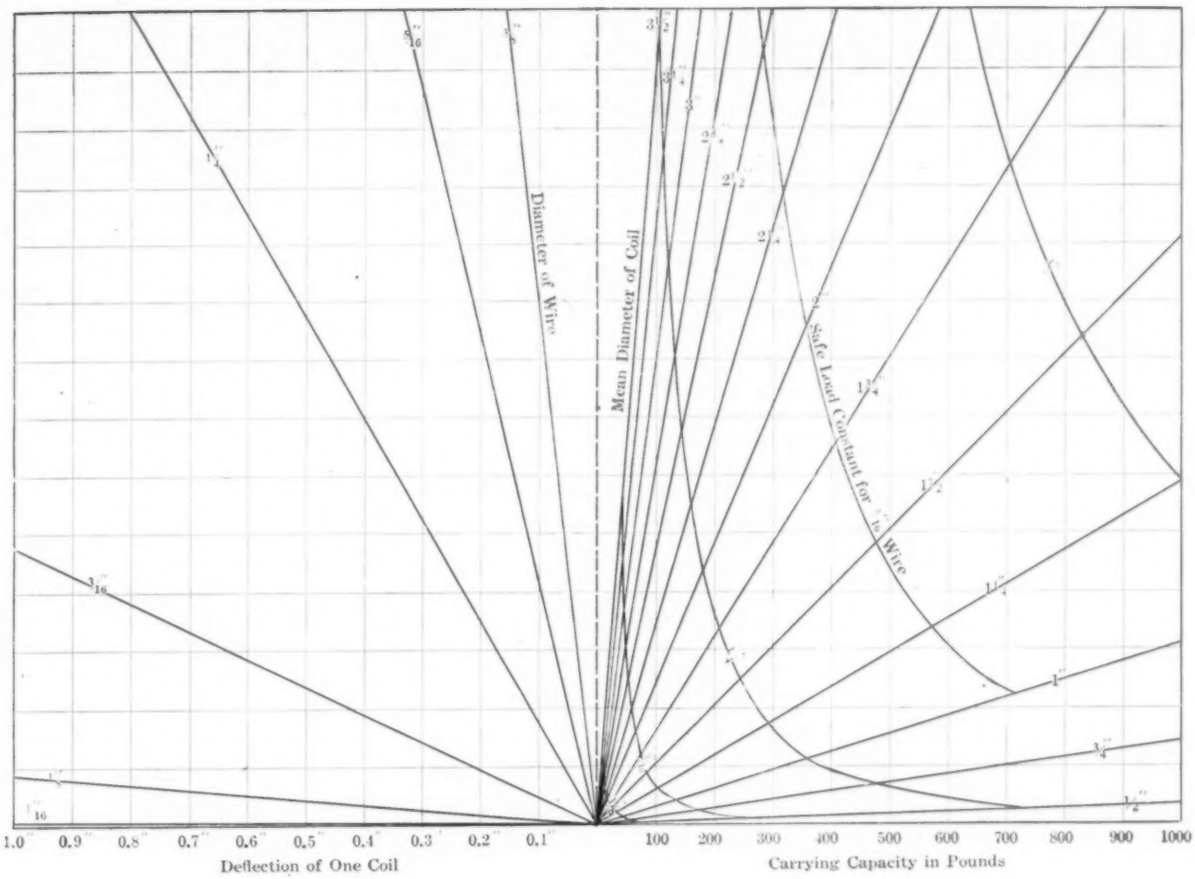
The upper chart is plotted for helical springs of round wire from ⅛ inch to ⅜ inch in diameter, both inclusive. The lower chart is plotted for helical springs of round wire from ⅜ inch to 1 inch in diameter, both inclusive. The left-hand half of each chart gives the deflection of one coil for various sizes of wire; the right-hand half gives the corresponding loads and mean diameters of the coils. On the right-hand sides are curves marked "Safe Load Constant" for different sizes of wire. These represent the safe working load for the size of wire indicated and the mean diameter of coils shown. Other sizes of wire can be interpolated with ease. If the mean diameter is a constant, the safe working loads of springs made from different sizes of wire will vary as the cube of the wire diameter. If the mean diameter is a constant, the deflections under their safe loads, of springs made from different sizes of wire will vary as the reciprocals of the diameters.

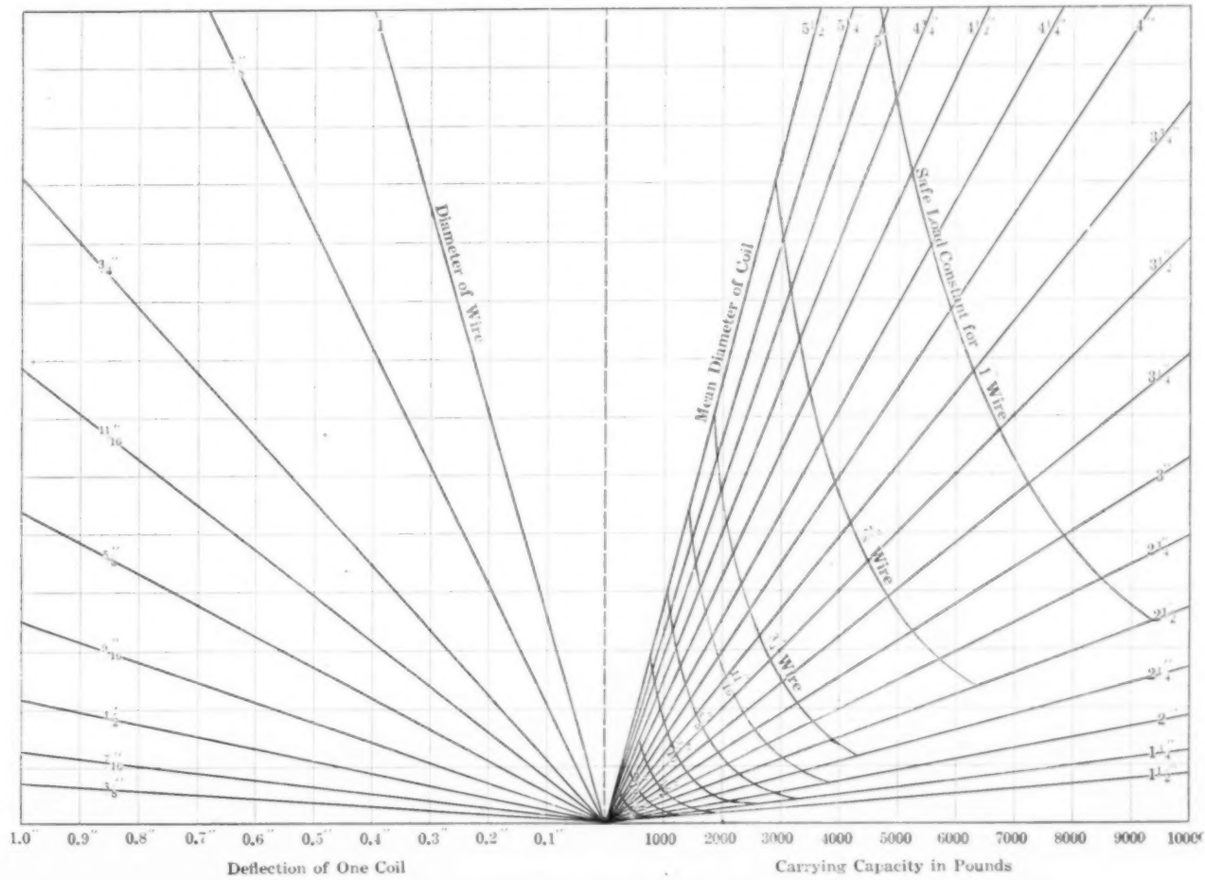
Examples

1. Find the size of wire and number of coils of a helical wire spring to carry a load of 4000 pounds. The coils must have a mean diameter of 4 inches and the spring a total deflection of 1 inch. Enter the lower chart at the point indicating 4000 pounds and trace upward to the intersection with the sloping line representing a mean coil diameter of 4 inches. This intersection is approximately on the safe load curve for ⅞-inch wire. From this intersection trace horizontally to the left to the line of ⅞-inch wire diameter in the left-hand half of the chart. From this point of intersection trace downward to the scale at the bottom and read the deflection in inches per coil, which is about 0.29 inch. Thus a spring to satisfy the conditions of our problem must be made of ⅞-inch wire and contain 3½ coils.

2. What diameter of coil must be used for a spring made from ¾-inch wire to carry a load of 2200 pounds with a total deflection of 3 inches for 10 coils? The deflection per coil is 0.3 inch. Enter the lower chart on the left-hand side at the deflection of 0.3 inch and trace upward to an intersection with the sloping line representing ¾-inch wire. From this intersection trace horizontally to the right to an intersection with the 2200-pound ordinate. This point is near the 4-inch mean coil diameter line and well within the safe load line for ¾ wire. Thus the mean coil diameter required is 4 inches.

3. What is the safe working load and deflection of a spring made from 1½-inch round wire and with an internal diameter of coil of 4 inches? This size of wire is not plotted on the chart. Let us take, therefore, a wire of one-half the size or ¾ inch in diameter and a mean coil diameter of 5½ inches equal to the mean coil diameter of a 1½-inch wire spring with an internal coil diameter of 4 inches. For this assumed spring the safe load is 1800 pounds and the deflection 0.635 inch, as found from the lower chart. Multiply this load by 8, the ratio of the cubes of the wire diameters, and we have 14,400 pounds as the safe load for the spring specified; similarly, multiply the deflection by 0.5, the ratio of the reciprocals of the wire diameters and we have 0.318 inch as the deflection per coil of the spring specified.


Diameter of Wire
Mean Diameter of Coil
Safe Load Constant for 1/8" Wire
1.0" 0.9" 0.8" 0.7" 0.6" 0.5" 0.4" 0.3" 0.2" 0.1"
Deflection of One Coil
100 200 300 400 500 600 700 800 900 1000
Carrying Capacity in Pounds


Diameter of Wire
Mean Diameter of Coil
Safe Load Constant for 1 Wire
1/8" Wire
1.0" 0.9" 0.8" 0.7" 0.6" 0.5" 0.4" 0.3" 0.2" 0.1"
Deflection of One Coil
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
Carrying Capacity in Pounds

PROPORTIONS OF HELICAL SPRINGS

Proportions of Helical Springs

The accompanying charts are plotted from Begtrup's well-known formulas for the safe load and deflection of helical springs. The upper chart is plotted for a range of wire diameters from 1/8 inch to 3/8 inch, both inclusive. The lower chart is plotted for wire diameters from 3/8 inch to 1 inch, both inclusive. The right-hand half of each chart has a scale of spring-carrying capacities in pounds, sloping straight lines representing various mean coil diameters and a series of curved lines crossing these sloping lines and representing safe loads for various wire diameters. The left-hand side of each chart has a scale representing deflections of one coil in inches and sloping lines representing wire diameters.

A. To find the size of round wire and the number of coils for a helical spring, having given the load in pounds, the total deflection in inches and the mean diameter of the coil, enter the right-hand side of the chart on the lower scale at a point representing the given load. From this point trace upward to an intersection with the sloping line representing the mean coil diameter. If this point of intersection falls on, or very near, one of the lines of safe load constants, the diameter of wire specified on that line is the diameter required. If this intersection does not fall on or near one of these safe load constant lines the size of the wire required must be found by interpolation, or the next larger size wire may be used. From this intersection trace horizontally to the left to an intersection with the sloping line in the left-hand half of the chart representing the size of wire determined upon. From this second point of intersection trace vertically downward to the scale at the bottom. From this scale read the deflection per coil for the spring. Divide the total deflection given in the problem by the deflection per coil, and the result will be the number of coils in the spring.

B. To find the mean diameter of the coil for a round-wire helical spring, having given the load in pounds, the total deflection in inches, the diameter of the wire in inches and the number of coils, divide the total deflection by the number of coils to find the deflection per coil. Enter the chart at the point on the scale at the left-hand side representing the deflection per coil just found, and trace upward to the sloping line representing the diameter of wire given. From this point of intersection trace horizontally to the right to an intersection with the ordinate in the right-hand half of the chart representing the given load. If this point of intersection also falls on one of the sloping lines the dimension on that line is the mean diameter of coil required. If this intersection does not fall on one of these sloping lines, the proper value for the mean diameter of coil can be found by interpolation.

C. To find the safe load for a round-wire helical spring, having given the size of wire, and the mean diameter of the coil, find the point of intersection of the curved line representing the safe load constant for the size of wire given and the sloping line representing the mean diameter of the coil. From this point of intersection trace vertically downward to the scale at the bottom of the chart representing the carrying capacity in pounds. Read the safe load required from this scale.

D. To find the total deflection of a round-wire helical spring, having given the size of wire, number of coils, diameter of the coils and the load, trace vertically upward from the point on the carrying-capacity scale representing the given load to an intersection with the sloping line representing the mean diameter of the coil. From this point of intersection trace horizontally to the left to a second point of intersection with sloping line representing the diameter of wire. From this second point of intersection trace vertically downward to the scale of deflection for one coil. From this scale read the deflection for one coil for the spring specified. Multiply this deflection for one coil by the number of coils to find the total deflection required.

E. To find the safe load for a round-wire helical spring of a size of wire greater than those represented on the charts, find the safe load for a size of wire within the limits of the chart and for the mean coil diameter specified. Divide the cube of the diameter of the wire specified by the cube of the diameter of the wire selected to use on the chart. Multiply the safe load found for the smaller wire by the quotient of these cubes; the product will be the safe load required.

F. To find the total deflection for a round-wire helical spring made from a size of wire larger than those represented on the charts, select a smaller size which is within the range of the chart and solve for the total deflection using the mean coil diameter and number of coils specified for the larger wire. Divide the reciprocal of the diameter of the larger wire by the reciprocal of the diameter of the wire selected, and multiply the deflection found for the smaller wire by this quotient; the result will be the total deflection required.

G. To find the safe load for a square-wire helical spring solve for a round-wire spring, using the method described under *C*, and multiply the result thus obtained by 1.2.

H. To find the deflection for a square-wire helical spring solve for a round-wire spring of the same diameter, using the method described under *D*, and multiply the result thus obtained by 0.589.

The Mechanism of the Watch You Carry

A Watch Movement Is a Small Automatic Machine Familiar in Appearance to Everybody, but Understood in Detail by Very Few

BY W. H. EBELHARE*

It has long been believed that horology formed a science by itself, and for a long time the watchmaker would not listen to anything about mechanics, pretending that its application to his work was impossible. This feeling has by no means disappeared. On the other hand, mechanics in general seem to have been governed by the hereditary instinct that horology was something entirely apart from their line of work. Even in the machine department of a watch factory, where there is every opportunity for investigation, men are woefully ignorant of even the general principles of a watch movement. And yet a watch represents nothing more than a refined application of every-day machine-shop principles. The movement may be considered in the nature of a small automatic machine, composed of a train of gears and pinions, springs, levers and balance wheel; the whole being made to conform to a circle of given size, as in Fig. 1, and automatically and accurately dividing time into fifths of seconds and registering it in seconds.

Pendent and Lever Sets

The key wind is a relic of the past, found principally in grandfather's watch or some old Swiss affair. Those engaged in the making of watches have almost forgotten the key wind, and are reminded of it occasionally in the advertisement of a belated dealer who represents his goods as the "keyless wind." But their manufacture has long since been discontinued, and all modern watches are stem wind and divided into two classes, namely, pendent set and lever set. The pendent consists of that part of the watch containing the crown end of the stem. For quite a long time after the advent of the "stem wind," all watches were made lever set. But the convenience of the stem set has caused the latter to be quite universally adopted, the lever set being confined almost exclusively to railroad use, where all employees running on time are required to carry a watch with lever set.

This requirement is brought out by the possibility of the stem set assuming a setting position while one is toying with the stem or lifting the watch out of the pocket with difficulty. This is not likely to happen often, and, in fact, is a highly improbable occurrence; but the possibility is there, nevertheless, and poor stem work in an otherwise good timekeeper will occasionally occur, and such a watch in the hands of a train despatcher or conductor might result in a serious accident. The intention is to eliminate all possibility of such an occurrence.

Setting Mechanisms

The devices used to throw a watch from "wind" into "set" by the pulling out of the stem are quite ingenious. The simplicity of some command one's admiration, while the complex nature of others excites the curiosity as to what troubles were encountered before the problem was solved. The effect produced by all of them is the same,

FIG. 1. THE E. HOWARD 16 SIZE 23 JEWEL WATCH MOVEMENT

that is, to cause a piece of mechanism (the clutch floating on the stem) to move in a direction opposite that of the pull. As shown in Fig. 2, by the pull on the crown, clutch *A* is disengaged from winding pinion *B* and thrown into engagement with the interset wheel *C* engaging with the dial train; spring *D* having greater leverage on lever *E* than lever *F*, causes the point *G* to strike lever *F* which shifts the clutch. A little study of Fig. 2 will show how the action takes place.

Another admirable arrangement, shown in Fig. 3, is very simple in its action. As the stem is pulled out, the lever *A* by means of spring *B* is made to slide along stud *C* and act against clutch lever *D* at *E*. *D*, however, is not a floating lever like *A*, and the pressure at *E*, therefore, causes the clutch to move in an opposite direction to the movement of the stem.

The Dial Train

The dial train, consisting of those wheels directly under the dial and the principal function of which is to secure the movement of the hour hand and also to set the watch, includes the cannon pinion to which the minute hand is attached, the minute wheel, the minute pinion, the hour wheel which carries the hour hand, and the interset wheel. They engage with each other in the order named. The cannon pinion is frictioned to the center staff by two slight indentations from the outside making it just tight enough to carry the dial train so that the dial train is in constant motion the same as the train proper, actuated by the center staff. When employed for setting, the power is applied at the opposite end of the train by the interset wheel, and, of course, the cannon pinion not being tight slips during this operation. If it were solid with the staff, aside from the difficulty of manufacturing, it would be impossible to move it, the escapement preventing this.

We now arrive at some practical work in gearing. The sketches, Figs. 4 and 5, give a good idea of the arrangement of the mechanism in the watch, the parts all being shown to enlarged scale. While the dial train is illustrated in these drawings, for convenience of reference a separate detail is presented in Fig. 6.

The Hour and Minute Wheels

Since the center wheel makes one revolution per hour, so of necessity must the cannon pinion, to which is attached the minute hand. The cannon pinion *a*, Fig. 6, engages with the minute wheel *b*, to which is attached the minute pinion *c* engaging with hour wheel *d*. The hour wheel is fitted free on the stem of the cannon pinion, having an independent motion thereon, and carries the hour hand. The hour wheel should complete one revolution on its axis in 12 hours, or as the minute hand completes one revolution the hour hand makes 1/12 of a revolution, the ratio thus being 12 to 1.

Let us assume a group of dial wheels with the following number of teeth: Cannon pinion, 12 teeth; minute wheel, 36; minute pinion, 10; hour wheel, 40 teeth. The teeth on the minute wheel and cannon pinion, 36 and 12, respectively, are in the ratio of 3 to 1. As the hour wheel has 40 teeth, and the minute pinion fast to the minute wheel, 10 teeth, it follows that the minute wheel and pinion revolve four times as fast as the hour wheel, hence we have ratios of 3 to 1 and 4 to 1 com-

*Model maker and draftsman, E. Howard Watch Company.

pounded, giving a velocity ratio between cannon pinion and hour wheel (or minute hand and hour hand) of 12 to 1.

Another Wheel Group

In small watches or low-priced ones we find this group: Cannon pinion, 10 teeth; minute wheel, 30; minute pinion, 8; hour wheel, 32 teeth.

Here again the minute wheel and cannon-pinion teeth are in the ratio of 3 to 1 and the hour wheel and minute pinion in the ratio of 4 to 1, so that as in the previous case, the minute-hand and hour-hand velocities are in the ratio of 12 to 1.

Suppose we reverse conditions: The hour wheel rotating once on its axis causes the minute wheel and pinion to make four revolutions; the minute-wheel making one revolution causes the cannon pin to revolve three times; hence the minute hand carried by the cannon pinion travels 3×4, or 12 times as rapidly as the hour wheel and hour hand. The interset wheel does not enter into the calculation as it is merely an intermediate wheel connecting with the setting device.

We will now refer to the train proper, shown in the development in Fig. 5, starting with the main wheel, or barrel, as it is termed, since it contains the spring.

The Main Spring

The average mechanic is apt to attach but little importance to this feature, simply making sure that it is sufficiently strong. However, experience has developed certain rules by which we are governed to insure best results. In practice two-thirds the interior radius of the barrel has been adopted as the value of *a*, Fig. 7; the regularity of the power from beginning to end increasing with the length of spring; also it is the custom to make the hub radius equal to one-third of the interior radius of the barrel. If the hub is greater than this we do not obtain a sufficient number of turns of spring, and if we make it smaller the spring is very apt to break; or if the temper is not the best it is apt to set. Also, if the spring is short, relative to the spring space, it will set and there is thus a loss in maintenance; and, *vice versa*, if the spring is long, it tends to fill the barrel and prevents the maximum number of revolutions of barrel from being obtained.

Pivots and Jewels

While on the subject of main springs, a word as to friction may not be out of place. In high-grade watches friction is reduced to a minimum. This is done in part by the introduction of jewels as bearings, and in part by the reduction of the diameters of the pivots. To those unacquainted with the fact, it may be interesting to note that the pivots of nearly all balance staffs measure from 0.010 to 0.012 cm., equivalent to 0.004 to 0.005 inch. These pivots carry the heavy balance, making 18,000 oscillations, which is equal to 24,000 revolutions per hour; and the same staff in the same bearings, unless accident prevents, will last for years, requiring no attention other than cleaning and oiling.

The fewer the jewels contained in the watch the heavier the mainspring required. A 7-jeweled movement having the same train and given the same care will require a spring 0.004 (metric) (0.0016 inch) thicker than a 23-jeweled movement. As stated above, as the grade improves we reduce pivots and introduce jewels, and as we reach the 19-, 21- and 23-jeweled movements we run the pivots on ends also, as shown at *A*, Fig. 8, which considerably reduces friction, as a comparison of *A* and *B* will indicate. In all watches, however, the balance pivots are run as shown at *A*.

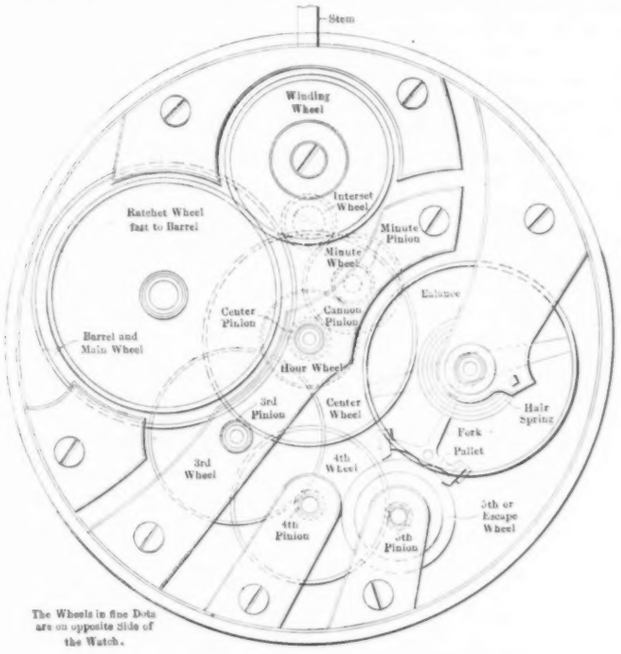


FIG. 4. WATCH MOVEMENT SHOWN DOUBLE SIZE

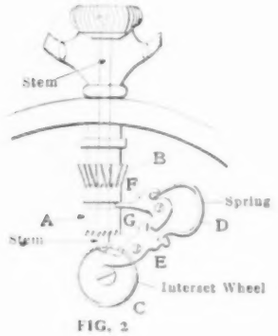


FIG. 2

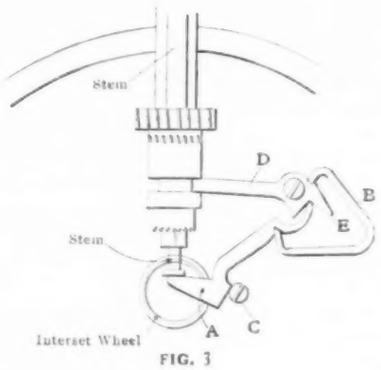


FIG. 3

WATCH-SETTING MECHANISMS

For a "16 size" watch the following spring thicknesses are customary: A 7-jeweled movement takes a spring 0.020 cm. (0.008 inch) thick; 15-jeweled, 0.019 cm. (0.0075 inch); 17-jeweled, 0.018 cm. (0.007 inch); 19-jeweled, 0.0175 cm. (0.0068 inch); 21-jeweled, 0.017 cm. (0.0066 inch); 23-jeweled, 0.016 cm. (0.0063 inch). As a rule the thinner the spring the less the breakage is apt to be, an added advantage characteristic of high-grade watches.

An interesting feature to note in connection with main springs is the fact that during the warm weather or "dog days" the breakage of springs is at least 40 per cent. greater than during cold weather.

The Safety Pinion

Before taking up the method of figuring the train proper I wish to mention the safety pinion, which forms a means of protecting the train from injury in the event of the main spring breaking. The act of breaking imparts quite a shock to the movement, and unless the teeth are strongly made a safety device of this kind is necessary. Many watches are provided with safety features which do not require

them, yet as a safeguard against possible damage they are applied.

The safety pinion consists of a pinion attached to the staff by means of a triple thread which is employed to prevent jamming. It will be understood that when the watch is running the pinion is kept tight against its shoulder on the staff. Now, if the spring breaks, a reverse action takes place, the recoil causing the pinion to unscrew, and detach itself from the staff. If a single thread were used, the constant pressure of the pinion against the shoulder would so tighten it that the recoil due to the breakage of the spring would not be sufficient to loosen it, hence the reason for the triple thread.

In watches of later design the shock of the recoil is absorbed by the ratchet wheel which takes it away from the train entirely. This mechanism is called a safety barrel and very substantially built. From the watch to the automobile is a wide jump, but shock absorbers were first employed in watches.

The Watch Train

The wheels of a watch have a double duty to perform: First, to transmit motion from the main wheel to the escapement; second, to reckon the number of oscillations accomplished by the balance wheel in a given time and indicate this time on a dial. The train is laid out to multiply progressively the speed of the first wheel, or barrel. For instance, if the barrel makes 5 revolutions on its axis, the train will cause the escape wheel to make 20,000 revolutions in the same time. It will be seen that the speed has been considerably increased and some idea of the resulting decrease in power may be obtained by taking out the pallet and balance and applying a toothpick to the escape wheel to turn it in a direction opposite that in which the watch runs, which is equivalent to winding the main spring, but which would take a long time to accomplish. Note the almost entire action of resistance to this operation and then apply the toothpick to the barrel and note the difference. In one case you are apt to damage the escape wheel; in the other you will have no difficulty in breaking the toothpick. Then try the experiment progressively, starting with the escape wheel, and as you approach the center note the increase in resistance. This experiment is interesting and instructive as well.

Train Computations

In all modern watches above 27 mm. the balance wheel makes five oscillations

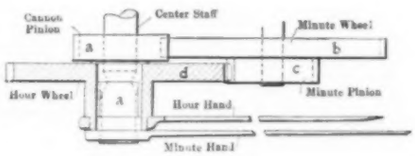


FIG. 6. DIAL TRAIN

to the second, which is equal to 18,000 per hour. Let us consider the train in the Howard watch, which is required to run 48 hours. Practice has determined some quantities; for instance, we have the choice of 6, 7 or 8 leaves for the fifth or escape pinion; 8, 10, or 12, as the number for the third and fourth pinions; 10, 12, or 14 as the number for the center pinion. The Howard watch has 12 for center, 10 for third, 10 for fourth, and 8 for the fifth or escape pinion, as indicated in Fig. 9 The barrel in this case is constructed to permit of 7 1/5 turns in the course of running down and should run 48 hours.

$$\frac{80 \times 7\frac{1}{5}}{12} = 48 \text{ hours.}$$

Intermediate Wheels

In computing the intermediate wheels we have as a starting point the fact that the balance is required to make 18,000 oscillations to one revolution of the center wheel. In the lever escapement the action of each tooth of the escape wheel corresponds to two oscillations of the balance; therefore, as the escape wheel has 15 teeth we will assume it has 30 teeth. Then

$$\frac{18,000}{30} = 600,$$

which equals the number of revolutions of escape wheel per hour.

With the center wheel making one revolution, and the escape wheel (with pinion of eight teeth attached) making 600, what is the number of teeth for center wheel, third wheel and pinion, and fourth wheel and pinion?

We know that the fourth wheel to which is attached the second hand must make 60 revolutions per hour, that is, 60 revolutions to one of the center wheel. Since the escape pinion having eight teeth makes 600 revolutions and the fourth makes 60 revolutions, we then have

$$\frac{600}{60} = 10 \times 8 = 80,$$

which is the number of teeth for the fourth wheel.

We have now to find the number of teeth of center and third wheels, having

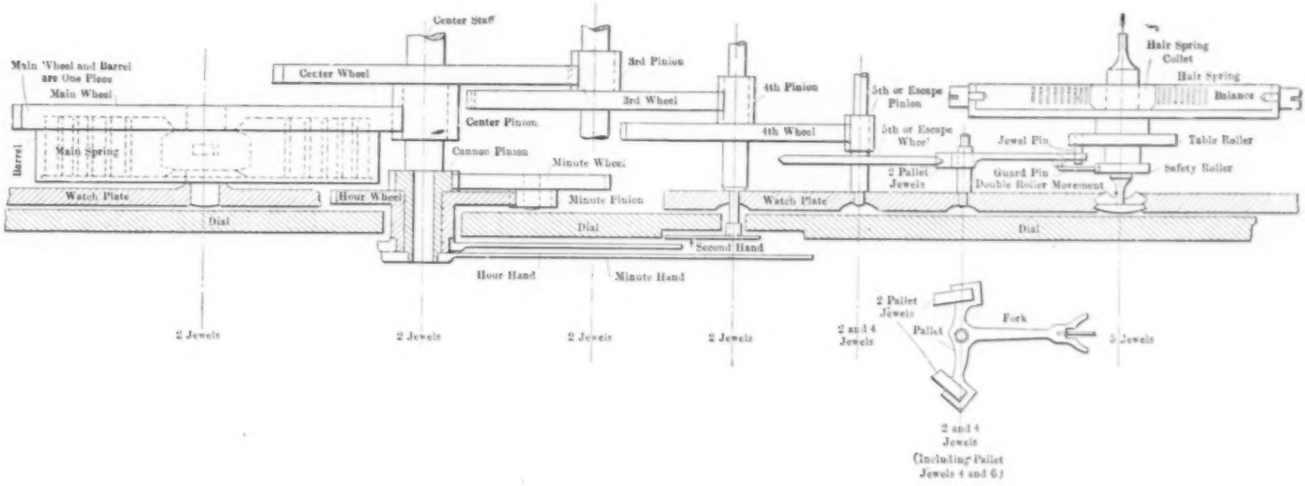


FIG. 5. DEVELOPMENT OF WATCH MOVEMENT ENLARGED

The center pinion having 12 teeth, we find the number of teeth for the barrel as follows:

$$48 \times 12 = 576 \text{ and } \frac{576}{7\frac{1}{5}} = 80,$$

or number of teeth for barrel. Or, having the number of turns, and number of teeth of barrel and pinion, how long will it run?

selected their pinions of 12 and 10 leaves, respectively, as well as the fourth pinion of 10 leaves. The Howard movement has an 8 to 1 ratio of center wheel to third pinion, and 7½ to 1 ratio of third wheel to fourth pinion to secure the 60 to 1 ratio necessary between center wheel and fourth wheel. That is, the third pinion of 10 teeth makes eight revolutions to one of the center wheel, hence 8 × 10, or

80 = the number of teeth for the center wheel, while 7½ × 10, or 75 = the number of teeth for the third wheel. Thus we have the train completed as follows: Barrel has 80 teeth; center wheel, 80; third wheel, 75; fourth wheel, 80 teeth. Center pinion, 12 teeth; third pinion, 10; fourth pinion, 10; fifth or escape pinion, 8 teeth.

To one turn of the barrel we have the escape wheel revolving

$$\frac{80 \times 80 \times 75 \times 80}{12 \times 10 \times 10 \times 8} = 4000$$

turns. Or the relation of barrel to center pinion, 80 teeth to 12 teeth, = 6⅔ to 1; center wheel to third pinion, 8 to 1; third wheel to fourth pinion, 7½ to 1; fourth wheel to escape-pinion, 10 to 1; which equals 6⅔ × 8 × 7½ × 10 = 4000, as shown in Fig. 9. Combinations in watch trains vary, sometimes owing to the construction, and also to meet the requirements as to the number of hours to run. An interesting feature in connection with the train is the fact that through the action of the escape wheel it assumes a state of rest, that is, it stops and starts 18,000 times an hour, or 180,000 times during the 10 hours we work.

The Escapement and Balance

This part of the watch movement requires considerable study to appreciate its full significance, and in a contribution of this nature it is utterly impossible to present it so that the reader can obtain a thorough knowledge of its functions. I will endeavor, however, to make clear the means employed in transmitting force to cause the balance to oscillate.

The escape-wheel teeth are shaped in a rather peculiar manner. Figs. 10 and 11 give some idea of the action taking place in the escapement; Fig. 10 shows it in a neutral position with the watch completely run down. If we wind the watch the tooth *a* will glide across the inclined face of pallet *b* raising it out of the path of the tooth, this action necessarily causing the pallet *c* to drop into the path traveled by *a* since it is pivoted at *d*, thereby arresting the progress of the escape wheel. This position, shown in Fig. 11 is called a locked position, and occurs twice with each tooth in one revolution of the wheel. In the meantime *e*, which is called the fork, moves back and forth, imparting motion to the balance by means of the jewel pin *f*. This jewel pin is firmly cemented in a roller, or as termed by a mechanic, a washer, secured by friction to the balance staff. As the tool *a* raises the pallet *b*, it follows that the fork moves to the right, and consequently carries the jewel pin with it until the fork is arrested in its progress by the backing pin *g*, which is made eccentric for adjustment. This action takes place very quickly, and the momentum given the balance causes it to continue on in the same direction until it makes three-fourths of a turn; it, however, does not make the full ¾ turn on the first impulse.

FIG. 7. Main Spring

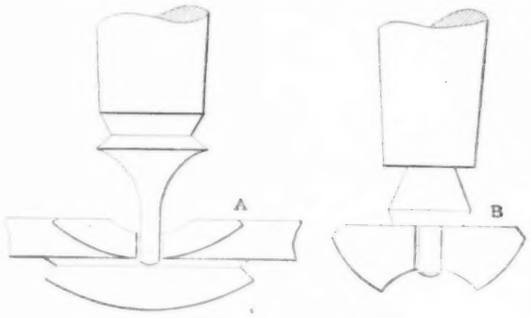


FIG. 8. Arrangement of Jewels

SPRING AND JEWEL DETAILS

The Action of the Hair Spring

The balance is interrupted in its progress in the direction given it by jewel pin *f* by the hair spring or balance spring as it is sometimes called, which, during this three-fourths of a turn is being wound up. The hair spring must unwind, and in doing so carries the balance in a reverse direction which unlocks escape tooth at *c*, Fig. 11. The instant the unlocking action takes place, the passage of the tooth along the inclined face of the pallet gives another impulse to the balance. This action of the jewel pin in the fork slot is very interesting, but is accomplished so rapidly that it is impossible to follow it while in motion. During the process of unlocking, the balance with its stored-up energy transmits through the jewel pin *f* motion to the pin *c*, and the unlocking takes place, the fork receives an impulse from the pallet end and transmits it to the balance.

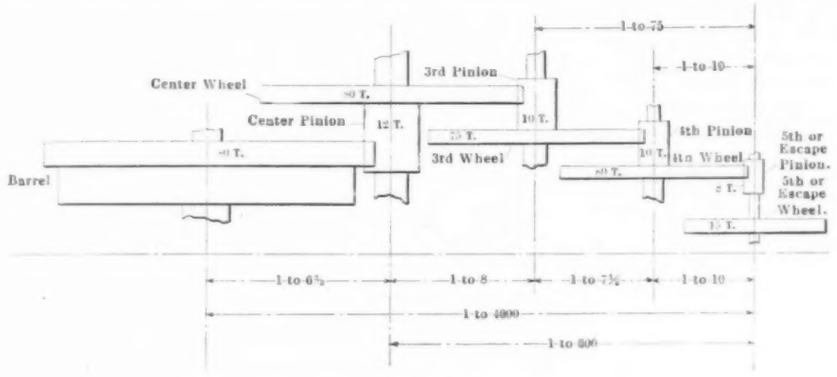


FIG. 9. WATCH TRAIN

The Balance Oscillation

The balance spring receives its motion from the body of the watch and yet controls and regulates it. A balance which receives a proper impulse will, with dial up or down, make one and one-half turns on its axis in one direction and one and one-half turns in the opposite direction. This, as explained above, is termed oscillation. Here we have another interesting feature. On the one hand we have a comparatively heavy balance-wheel oscillating at a rather high rate of speed, and an extremely small spring arresting this balance in its course, which reverses its action, obtains momentum, unlocks the escape tooth and receives another impulse. Thus back and forth it continues.

When the watch is completely wound up the balance makes longer arcs of vibration, or oscillation, than when the motive force is somewhat expended; for instance, when wound it takes a turn and one-half, this gradually diminishing as the maintenance falls off until toward the end of 24 hours it makes a turn and one-quarter only. One would naturally infer this would cause quite a variation in its timing qualities. It is here that the skill of the watchmaker and adjuster is manifested. It is his work to equalize the time of the long and short vibrations; that is, a long arc of vibration (1½ turns of balance) should occupy exactly the same time as a short arc (1¼ turns of balance); when a balance spring accomplishes this it is called isochronal. In theory an isochronal spring contains no error in itself. But to obtain practical

strange as it may seem, the momentum of the balance is sufficient to overcome for an instant the motive force contained in the barrel, as a study of the relation of escape tooth to pallet *c*, Fig. 11, will show. Pallet *c* is pivoted at *d*, and before *c* can get out of the path of the escape tooth it forces the wheel in an opposite direction to that in which it travels when applying force to the balance. With an eyeglass applied to a watch we can observe this interesting action. The instant, however,

isochronism we are obliged to introduce errors into the spring which are equal to, and the reverse of the errors caused by friction and other disturbing influences. When we accomplish this the vibrations will be isochronal, that is, the rate of turning will be the same for different arcs of vibration and position, and the spring will be truly isochronal.

The Compensating Balance

A balance that is bimetallic is called a compensating balance. It consists of an inner rim made of steel solid with the arm connecting the inner diameters and to

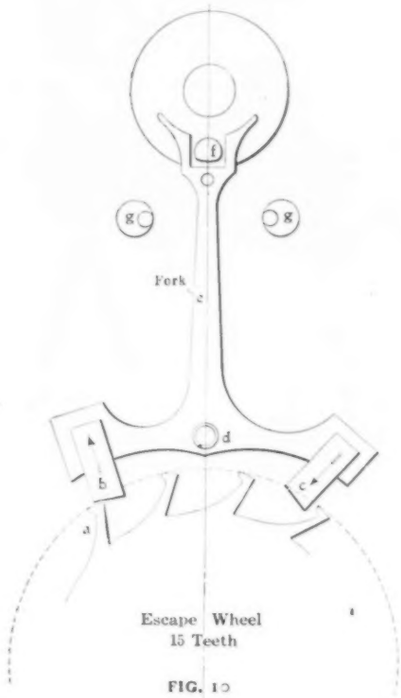


FIG. 10

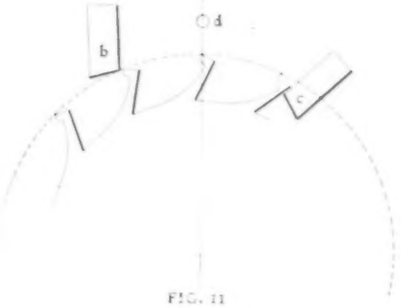


FIG. 11

THE ESCAPEMENT

which is fused a brass rim while in the rough. Upon the completion of the balance it is slotted at two opposite sides near the balance arm, so as to permit the free end to change its relation to the center. Screws made of brass or gold are attached, as a means of regulating, altering the weight in relation to the hair spring, and poising. There are two screws in the rim above the balance arm which are somewhat different from the others, and are called timing screws. These screws are employed to bring the watch to time without disturbing the regulator, which, as it leaves the factory is at zero. The other screws are called balance screws and are not disturbed after the above operations.

Temperature Tests

All watches of a fairly good grade are given a temperature test; that is, they are subjected to 90 degrees heat for 24 hours and to 38 cold for the same length of time. In a compensating balance there are more holes than screws. This is to enable the screws to be shifted as the temperature work requires. For instance, if a watch runs fast in heat and correctly in cold, we move a pair of screws (which are opposite each other so as to have the same effect in each half of the balance, and also to keep it in poise) toward the end of the rim or toward the slot. The amount they are shifted is determined by the number of seconds gained. By shifting the screws one hole, we alter the timing from 4 to 5 seconds per 24 hours; for instance, if we have a gain of 10 seconds in heat over cold, we move one pair of screws two holes and *vice versa*.

Heat causes the hair spring to lengthen, consequently making it weaker, and unable to vibrate the balance in the required time. At the same time heat affects the balance arm to lengthen it, thus giving a larger diameter of balance and adding difficulties to an already weakened condition.

On the other hand, cold shortens the hair spring, necessarily making it stronger, which serves to accelerate the balance; added to this we have the contraction of the balance arm due to cold, decreasing the diameter of the balance which has the effect of lightening the load of an already strengthened spring, which helps still further to accelerate the balance. To overcome this variation and cause the balance to vibrate or operate the same in regard to time in heat as in cold, the bimetallic balance referred to above was introduced.

The Action of the Balance

Fig. 12 shows, first, the balance in its normal condition with rims concentric as at *A*; second, the effect of cold; third, the effect of heat. The illustrations at *B* and *C* are purposely exaggerated to be the better understood. As the heat weakens the spring and adds to its load by increasing the balance diameter, the balance compensates for this by carrying the mass of metal nearer the balance axis, as shown at *C*. This change is effected by the proportion of the two metals, brass and steel. This proportion is only arrived at by careful experiment. The outer brass rim expanding more than the steel inside can extend in one direction only, and that is as shown at *C*, which is equivalent to a smaller diameter of balance. In cold the reverse action takes place. The spring is stronger, the balance smaller. To compensate for this, the contraction being greater in brass than steel, causes the balance rim to straighten as at *B*, thus carrying the mass of metal farther away from the axis and giving a retarding effect. The balance wheel in this way acts as a pendulum. As we wish the clock to go fast or slow we raise or lower the pendulum. In the watch the balance automatically

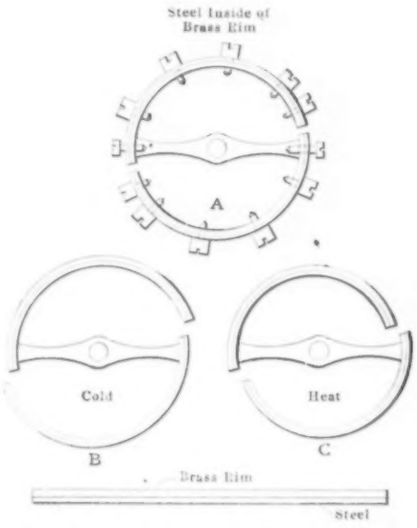


FIG. 12. THE COMPENSATING BALANCE

changes to accelerate or retard the action as temperature may require.

Number of Jewels

In determining the number of jewels in American watches, five can always be assumed as the number contained in the balance, these consisting of two jewel bearings and two end stones, and one roller jewel which takes action from the pallet and fork.

Then there are always two jeweled pallets. The above constitute the seven primary jewels which are found in all American-made watches. As a rule, it can be assumed that there are as many jewels on the dial side of a movement as are seen on the train side.

To count still further, observe if the pallet axis is jeweled; if so, that means 9 jewels. Then observe if the fifth or escape wheel is jeweled; if so, that makes 11, and so on through to the barrel.

A 7-jewel movement is one containing the least number of jewels. An 11-jewel movement includes the seven primary with the pallet axis and the escape axis jeweled. A 15-jewel movement includes jewels for the train from balance to third-wheel. A 17-jewel movement includes jewels from balance to center-wheel. A 19-jewel movement has either the escape wheel capped the same as the balance, or a jeweled barrel. A 21-jewel movement has either the pallet and escape wheel capped, or the escape wheel capped and barrel-jeweled. A 23-jewel movement which is the highest, includes the foregoing entire jewel train, with escapement capped and barrel-jeweled. The jewel positions are all indicated in the train development represented in Fig. 5.

Electric Furnaces Used in Treating Steel

Different Styles of Furnaces for Experimental and Practical Work and Their Construction. A Pyrometer for Use with Them. A Welding Outfit

BY E. F. LAKE

The electric furnaces, heating appliances and heat-measuring instruments are fast being adopted for the practical work of making and heat treating steel, and The Hoskins Company, 93 Erie street, Chicago, Ill., is manufacturing a pretty complete line of this kind of apparatus. The quickness with which the desired heat can be attained in this kind of furnace and the ease with which it can be held at any required point for almost any length of time, makes of them very desirable instruments for the heat treatment of steels. The ease with which the temperature can be raised and lowered either slowly or quickly, and the abolishing of the fuel gases which work harm to the steel treated are also very important points which count in favor of the electric furnaces.

The mechanical construction of electric furnaces is not at all complicated, therefore in this regard they can compete with any of the high-grade furnaces used to anneal, harden or temper steel. About the only point to be settled in regard to their use commercially is the cost of operation on a large scale, and if this cost can be kept down to that of the gas furnace, their use for practical work will be assured. Of course, where the pieces to be heat treated are very small, or on larger work where quality is the main consideration, irrespective of cost, this cost of operation is not a debatable question.

FIG. 1. COMBINED CRUCIBLE AND MUFFLE ELECTRIC FURNACE

Small Furnaces

The line of small electric furnaces built for this class of work is quite varied, and they can be obtained in most any style required. The furnace illustrated in Fig. 1 is designed to hold a No. 000 crucible when standing on its legs, as shown, the crucible and covers being shown to the right of the furnace. It can also be used as a muffle furnace by laying it on its side on the bent wire frame, shown at its right. When used in this way the flat plate, which is shown leaning against the side of the wire frame, is inserted in the furnace to lay the work on so it will not come in contact with the lining of the furnace and thus heat unevenly.

The lining used in this furnace is shown in front of it and is made of porcelain with a spiral groove for winding the heating coil in. This heating coil is shown in place with the positive and negative ends ready to connect to the wire furnishing the current. In this case arrangements are made for connecting with an incandescent lamp socket which will furnish all the heat necessary for this type and size of furnace.

It can be used on a direct or alternating current and is absolutely guaranteed not to burn out at temperatures up to 1000 degrees Centigrade, or 1832 degrees Fahrenheit, the cost of operation is less than 5 cents per hour and it requires but 3½ amperes at 110 volts.

The heating coil in this style of furnace is made of a special wire composed of nickel and chromium in different percentages to suit different requirements. The most commonly used wire is composed of 5, 10, 15 and 20 per cent. chromium plus 95, 90, 85 and 80 per cent. nickel. The different combinations of these two elements are covered by patents by The Hoskins Company. This wire has 60 times the resistance of copper and about six times the resistance of platinum while it is much cheaper and does not decrease in size, like the latter, when subjected to a high temperature for a long period of time. It also has a very low coefficient of expansion as well as having about the same tensile strength as steel.

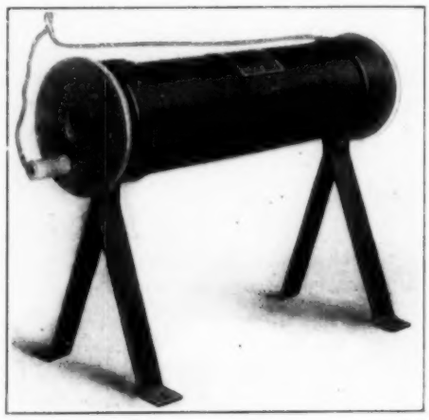


FIG. 2. FURNACE FOR OBTAINING CARBON CONTENTS BY THE DIRECT METHOD

To it is largely due the success of this company with its small furnaces which are guaranteed not to burn out at temperatures up to 1832 degrees Fahrenheit, and which are capable of standing a temperature much higher than this for a short period of time. In fact they have been used frequently for melting copper.

The space between the sheet-metal outer shell of the furnace and the porcelain lining, with its heating coil, is packed with a special heat insulator.

Other Styles of Same Type

The furnace shown in Fig. 1 is also made with 2, 4, 6, 8 or any number required, combined in one plate which serves for the top of the furnaces. This makes a very handy apparatus for carrying on a number of experiments at the same time or for handling a large number of small pieces in practical commercial work.

The furnace shown in Fig. 2 was designed especially for determining the carbon content of steel by the direct method. The inside diameter of the tube is 1 inch and it is 12 inches long, with both ends open. At a constant temperature as high as 1850 degrees Fahrenheit this will give

a uniform heat in 10 inches of the tube length. In other words the work should be kept at least one inch from both ends owing to the cooling effects of the outside atmosphere.

This furnace might also be applied to the hardening of long slim pieces such as rods, drills, reamers, etc., as its construction is the same as the combined crucible and muffle furnace and it can be

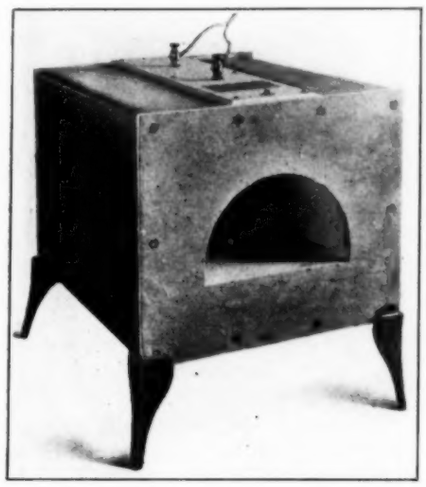


FIG. 3. ELECTRIC MUFFLE FURNACE

operated at the same temperatures. It could also be used successfully in larger sizes and one end can be sealed if desired.

The muffle furnace shown by Fig. 3 has the same mechanical principles used in its construction. The stock furnaces are made in three standard sizes, these being 3 inches wide, 1⅝ inches high and 5 inches deep; 4 by 2⅜ by 7¾ inches and 5 by 3¾ by 9⅞ inches, but other sizes to suit the requirements of special shaped pieces could easily be made, owing to the simplicity of the construction.

These furnaces, like the others, are guaranteed against a burn out up to 1832 degrees Fahrenheit, but another type of the same style of furnace is built which will stand higher temperatures with a greater durability for continuous service.

Hot plates are also made with this wire coil underneath, for generating the heat, which are very useful for laboratory work.

Carbon-resistance Furnace

Where higher temperatures are needed, such as those required for melting metals with a high melting point, the furnace shown in Fig. 4 gives much more satisfactory results.

This furnace is shown with the opening in the top, but it can be made with the opening in the side, for a muffle furnace, if so desired, or tube furnaces, either vertical or horizontal, can be made on this principle.

The mechanical construction of the furnace is shown by the line drawing in Fig. 5, in which *A* is the shell or case of the furnace; *B* the furnace chamber which has been made in sizes up to 15x15x15 inches and given good results in its operation; *C* is the carbon-resistance blocks which can be made any thickness from ⅛ inch to 2 inches to increase or decrease the resistance required in any size of furnace; *D* is graphite slabs; *E* the magnesia lining which is packed between the carbon-resistance blocks, or the graphite slabs and the outer shell; *F* a sheet-steel brace for each end; *G* shows the graphite rods; *H* the copper bus-bars and *I* the clamps for connecting the bus-bars to the graphite rods; *J J* are transite insulations; *K*, hand-wheels attached to rods which are threaded and screw through the end pieces *L*. *M* is a crucible which may be used in the furnace.

As will be seen, the furnace is one that can be easily repaired when any part wears or burns out, or is broken; for instance, the carbon resistance blocks may be lifted out and new ones put in their place by turning the hand-wheel *K* until there is no pressure against the blocks. This also loosens up the graphite slabs *D* so that they can be taken out and replaced with new ones. The graphite rods *G* are removed by loosening the clamps *I* and the screws attached to the hand-wheel *K*. The magnesia lining *E* is easily kept tight by filling in loose magnesia as it is needed, and as this is a cheap material, the cost is hardly worth considering.

Operating the Furnace

In operation the heat in the chamber is always in proportion to the current used, and this is very easily regulated by turning the hand-wheels *K* which increase or decrease the resistance by pressing together or loosening the carbon resistance blocks *C*. As the resistance is what generates the heat, a high or low resistance will give a high or low heat in the chamber of the furnace.

This furnace can be worked successfully under temperatures as high as 2000 degrees Centigrade, or 3632 degrees Fahrenheit, and it is very easily controlled at all temperatures between 900 and 2800 degrees Fahrenheit. It will melt anything from lead to platinum and while magnesia has been considered a non-fusible material in the past, it has been molded into crucibles and fused into a solid mass by heating in this furnace.

A special transformer is located at the top of the furnace and the current is sent through this for the purpose of

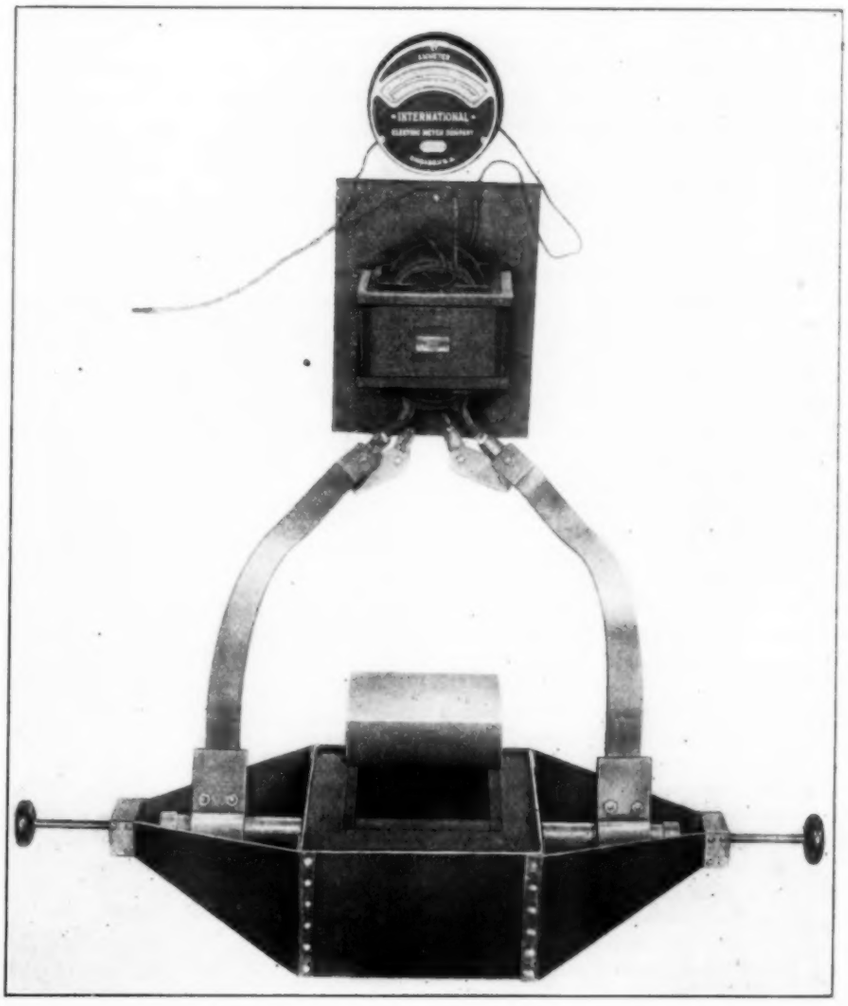


FIG. 4. ELECTRIC FURNACE FOR PRACTICAL COMMERCIAL WORK

changing the voltage, on the line, to one of low value, so there will be no danger to the operator. An ammeter is attached, as shown above the furnace in Fig. 4, so that the operator can see how much energy he is using. With this reading, and the time taken to reach any given temperature, the results obtained can be repeated very accurately and if records are kept of these, the results can be repeated after a long lapse of time.

This furnace is made for use on alternating currents only and will be manufactured to order in any size from a chamber 2x2x3 inches to 15x15x15 inches.

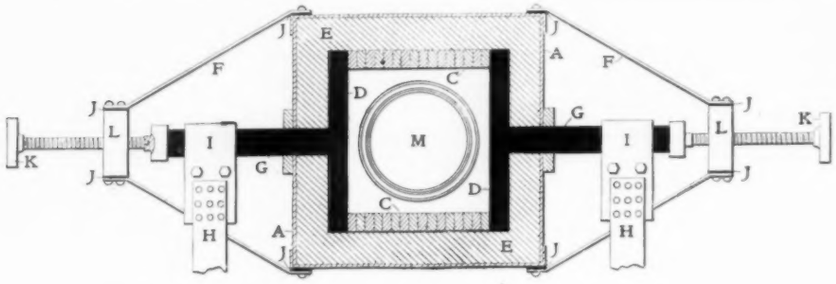


FIG. 5. DETAILS OF COMMERCIAL FURNACE SHOWN IN FIG. 4

The large variation in temperatures at which it is controllable makes it adaptable to many uses, other than the melting and tempering of metals. It can be used for the hardening and tempering of steel as well as for the melting of the same, by generating the exact amount of heat required.

Measuring the Temperature

For measuring the heat in the above furnaces, as well as in other places where high temperature measurements are required, this company makes the pyrometer shown in Fig. 6. The special feature of this pyrometer is the thermoelectric couple or hot end. It is made of the nickel-chromium wire described above and does not need the expensive and fragile porcelain or quartz tubes for a protection, that are used with many other pyrometers.

This wire has about four times the electromotive force of the platinum-rhodium which is usually used for couples; is not affected by furnace gases and is much cheaper than the latter metal, therefore it can be used in larger sizes, which makes it much more durable. By being able to use it bare, it can be placed in direct contact with the metal to be heat-treated and, therefore, there is no lag in the temperature registered on the pyrometer scale, as would be the case with a couple which is inclosed in a tube, owing to the necessity of heating the tube before the heat can penetrate to the couple. It does not alloy readily with the non-ferrous metals and can, therefore, be used safely in the foundry to judge the proper heat at which to pour these metals when melting them. By this use of it the temperatures which are found to give the greatest strength and density to any of the non-ferrous alloys can be repeated in different melts.

A Handy Autogenous Welding Apparatus

In the preparation of the couples the Hoskins Company has developed a very cheap and handy apparatus for welding the wires together which form the hot end. This is shown in Fig. 7 and consists of a "Prest-o-Lite" tank of the kind usually seen on the running board of an automobile for giving the light in the lamps. This gives the acetylene needed. The oxygen is obtained from the tank standing on the floor, the top only of which is shown. These can be obtained in almost any city at a small cost and the contents can be renewed when the pressure weakens. This one has a pressure of 250 pounds to the square inch. The contents of both tanks are brought together by rubber tubes and a brass Y with an individual cock for each tank. Another piece of rubber hose carries the combined gases to a special blow-pipe which is held in one hand of the operator while the work is held in the other, as shown in Fig. 7.

FIG. 6. HOSKINS PYROMETER WITH EXPOSED COUPLE

This makes a cheap, portable and handy outfit that any shop can put in, no matter how small, providing they have any welding to do. It gives all the heat that is necessary to weld steel sheets as thick as ⅛ of an inch, also rods and other pieces of small sections that are thicker than this. With this outfit it is necessary to wear colored glasses as the flame is so bright that the work cannot otherwise be seen. It can be operated by anyone with ordinary intelligence, but one precaution must be taken and that is to turn on the acetylene and light it before the oxygen is turned on. If this is not

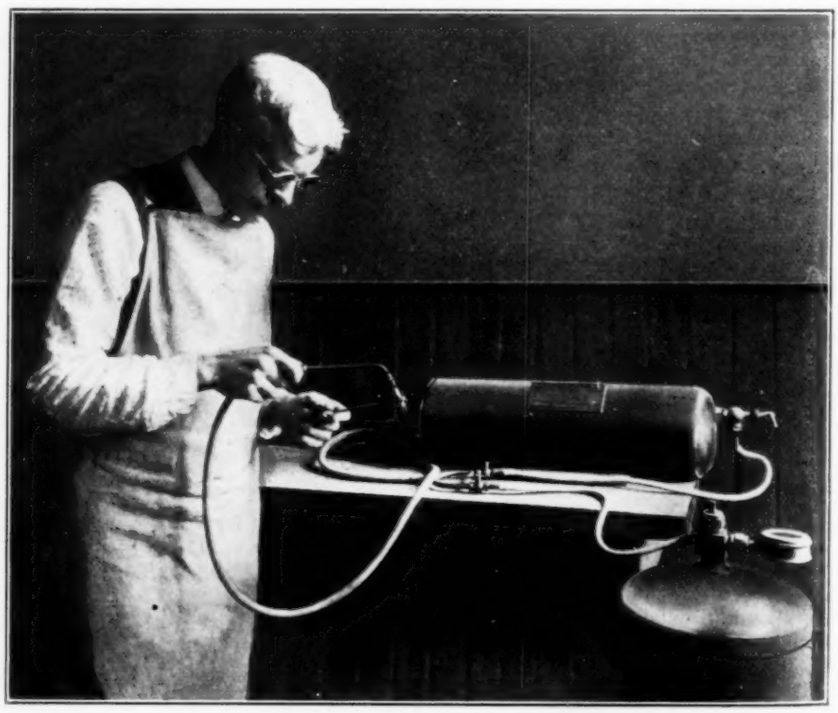


FIG. 7. A SIMPLE ACETYLENE-OXYGEN WELDING OUTFIT

done, or in other words, if the oxygen is turned on before the acetylene is lighted, the operator, tanks and other apparatus and part of the shop are liable to go up through the roof or through the side of a brick wall from the force of the explosion which is bound to occur.

The pressure of the oxygen in the tank can be ascertained by attaching a pressure gage to it as shown at the top of the tank in the illustration.

A Handy Bevel Tool

By Jas. Flannery

The accompanying photograph and sketch, Figs. 1 and 2, show a very handy bevel. Every machinist takes great pride in having in his kit of tools something that is a little out of the ordinary. Among my tools was a depth gage that looked like so much junk and I tried to see if I could not make it useful from one end to the other.

In setting a protractor unless one has a very good eye, it becomes necessary to use a magnifying glass to locate it at the degree required and care must be taken in locking it or it will move. Now my idea was to get away from all that unnecessary work. It will be seen that all that is required with the tool is to insert the blade or scale in the slot of the desired angle.

How the Bevel Tool is Made

To make one all that is necessary is to take a piece of machine or tool steel, plane, mill or grind it so it will finish ¼x1x6 inches long, then lay out holes as in the sketch. It is the best plan to cut the slots on a milling machine using the graduated vise. It is necessary in making the tool to use care in adjusting the vise as on that depends accuracy of the bevel. The slots are milled after the holes are drilled. As there are eleven slots on each side it will be the best plan to start in the center or hole No. 6 and with the vise set at zero mill slot No. 1; then move the table crosswise and come out to the end and repeat the operation. Then you will have a depth gage which you can use in the center or at the end as the case may require. Next loosen the vise and move to 1 degree, tighten up and mill in the third slot and continue adjusting the vise 1 degree at a time until that side of the tool is finished. You will have when done, the following angles:

Slot	No. 1,	90 degree
Slot	No. 2,	1 degree
Slot	No. 3,	2 degree
Slot	No. 4,	3 degree
Slot	No. 5,	4 degree
Slot	No. 6,	90 degree
Slot	No. 7,	5 degree
Slot	No. 8,	6 degree
Slot	No. 9,	7 degree
Slot	No. 10,	8 degree
Slot	No. 11,	9 degree

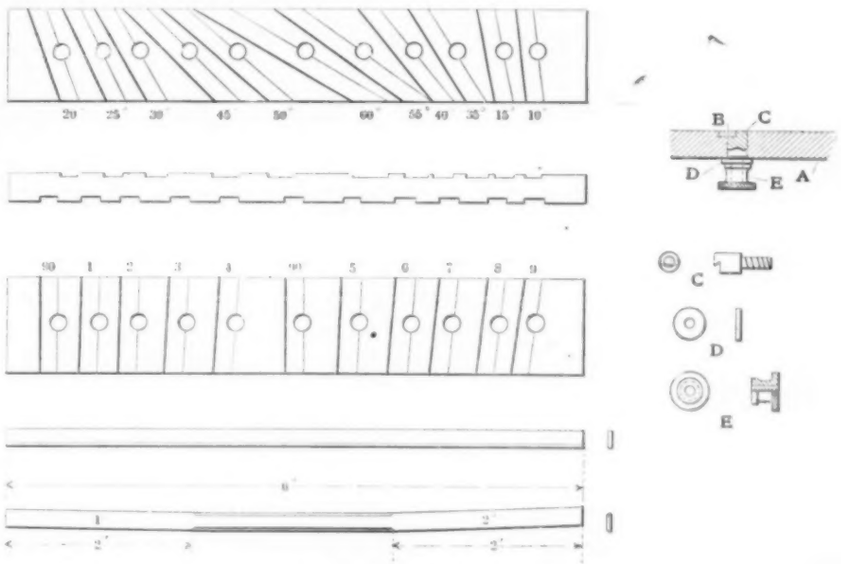


FIG. 2. A HANDY BEVEL TOOL

Care must be taken in locating slots on the opposite side, as they must pass across the holes and yet not run into each other. For a blade you can buy a ¼-inch scale 6 inches long if you have none in your kit. A great many have a depth gage such as Starrett makes; then you have part of the tool already made, as you can use the blade and lock nut for holding the scale in the blade.

Application of the Tool

The slots should be milled in flush on each side to suit the scale to be used. It will be seen that you can get from 1 to 9 degrees on one side and from 10 to 60 degrees on the other by 5-degree steps. Now to get 11, 12, 13, 14 degree, or any angle between 10 and 60 degrees, all that is necessary is to have another blade (or if desired use the same blade), leaving one edge straight, and on the other edge bevel one end 1 degree back 2 inches from the end, and bevel the other end 2 degrees. The sketch shows this blade with ends marked 1 and 2 degrees so as to prevent mistakes. Suppose an 11-degree angle is required; place the blade in the slot for 10 degrees and the end with the 1-degree bevel will give either 9 or 11 degrees, according to which way it is placed in the slot. Now place the blade in the same slot with the 2-degree bevel on the side desired and you get 12 degrees. For getting 13 degrees place the same blade (using the same end) in the slot marked 15 degrees. Turning the blade end for end in the same slot and using the end marked 1 degree will give 14 degrees and by using this same method you can get any angle from 1 to 60 degrees.

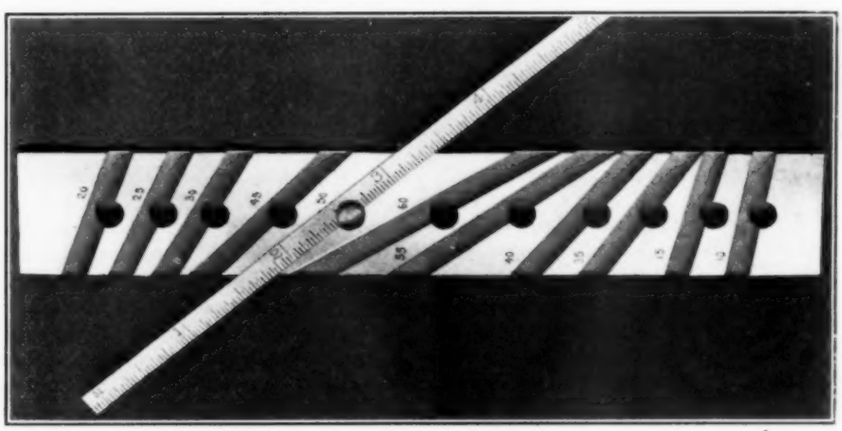


FIG. 1. A HANDY BEVEL TOOL

Other Uses

Diemakers will find this a very handy tool. They can make blades to suit almost any of their requirements. In the section in Fig. 2, *A* is the tool proper; *B* the blade or scale; *C* the clamping screw; *D* the washer; *E* the lock nut.

In milling the slots for the gripping device care should be taken to have the cutter set as near the center of the hole as possible so as to make the locking device applicable for all holes. This is not necessary with the split-button device used in the Starrett depth gage.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Making Cylindrical Laminated Cores

A few months ago our firm booked an order for 1500 laminated cores, as shown in Fig. 10. The foreman of our instrument department was instructed to make a dozen of them. This dozen worked out at 5 shillings and 6 pence each, with the result that I, the foreman of tool and machine rooms, was called on to estimate the cost of tools, etc., for making them, with the result that I agreed to make them for 6 pence each, the tools not to cost more than £10. The actual cost of the tools was only £8 10 shillings and of the cores 5 pence each.

Figs. 1, 2 and 3 are side and front elevations and a plan of the die for shearing the laminations. Figs. 4, 6 and 7 are side and back elevations and a plan of the die for piercing the rivet holes. Fig. 8 is a plan of the guide and stripper plate showing the self-centering device.

The parts *A B C D E F*, Fig. 1, are constructed from 4x⅝-inch section bright drawn steel cut from the bar 6⅝ inches long; *E* and *F* which act as distance pieces are cut 2⅛ inches long, they are then machined to 6½ and 2 inches long respectively. E, F and G form the bolster as I had not a bolster suitable for the job. The shear consists of 4x1-inch steel-faced iron cut and machined in the same way after being well annealed. At Fig. 3 the die is cut away at *N N* to permit the stop *K* to bury itself and to allow for reasonable support in *B* and *C*, which are guide and holder respectively. *N N* is then finished perfectly flat in its length, allowing one degree of vertical clearance to permit of clear cutting. Four holes 5/16 inch diameter are drilled through and countersunk for screws, to secure the die to the bolster *E F G*. Two 5/16-inch tapped holes *P P* at Fig. 3 secure the guide and stripper plate *C* to the die with

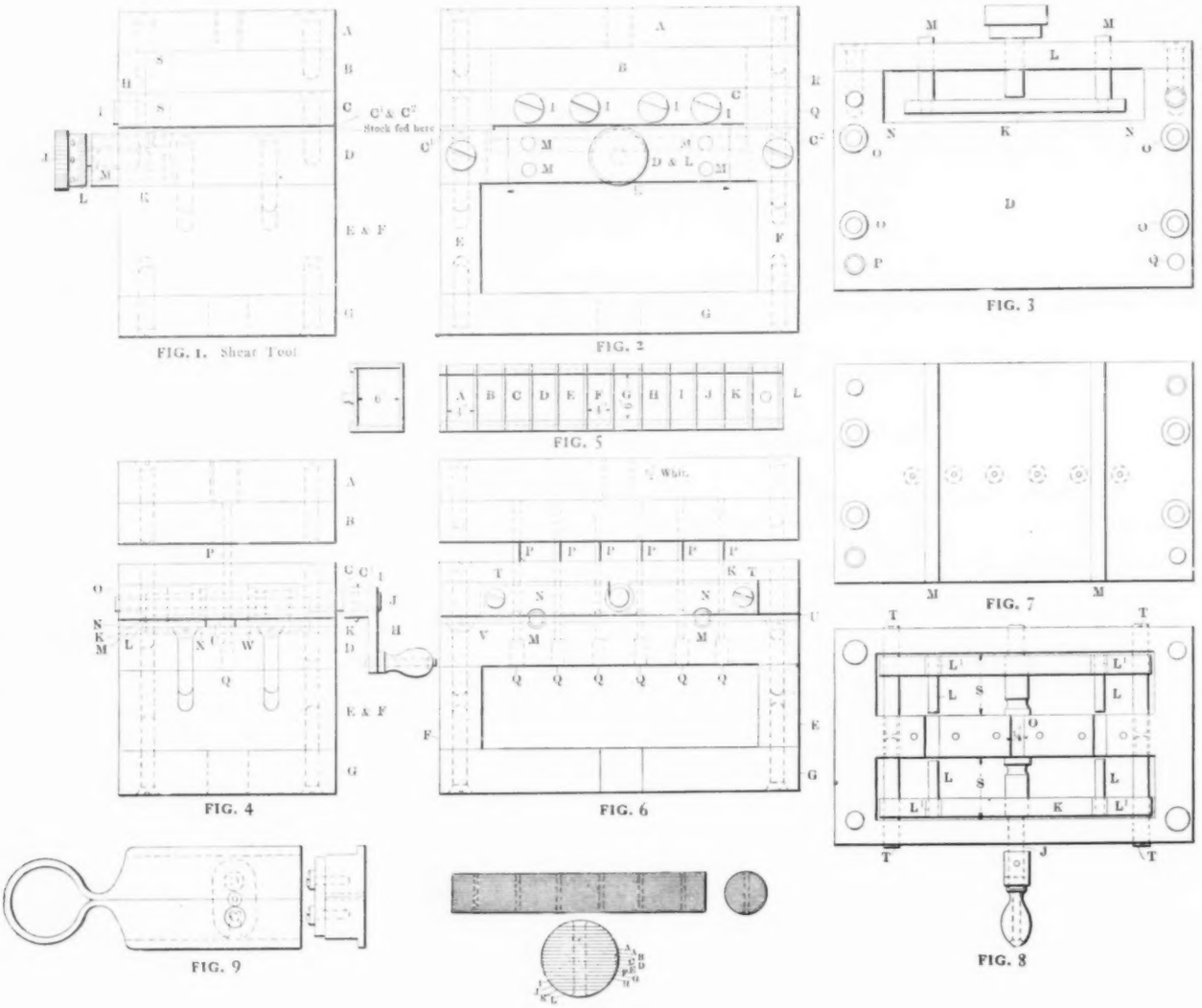


FIG. 1. Shear Tool
FIG. 2
FIG. 3
FIG. 4
FIG. 5
FIG. 6
FIG. 7
FIG. 8
FIG. 9
FIG. 10

MAKING CYLINDRICAL LAMINATED CORES

two pilot pins. Two 5/16-inch screws secure the strap *L* of 1x¾-inch machine steel, which in turn carries the stop *R* and micrometer screw *J*, Fig. 1, cut 40 threads per 1 inch and graduated to thousandths. The die now is quite ready for hardening. It is slowly heated to a bright red, then steadily quenched into a bath of brine, previously heated to about 100 degrees Fahrenheit, taking great care to hold it perpendicular in quenching so as to prevent warping. The temper is then drawn to a dark straw, and placed in the oil bath to cool. The next operation is to secure the guide and stripper plate *C* to the die and transfer the screw holes *P P* into *C*, then after securing them together by their original screw carefully transfer the pilot pin holes *Q C*; this done and the pilot pins placed in position carefully scribe off the slot way to take the punch *H*, which by the way, is made of 2x½-inch tool steel 4¾ inches long, machined, hardened and tempered in the same way as the die with the exception that instead of being slowly drawn to temper, it was quickly drawn by a white-hot tempering block so as to permit the face *S*, Fig. 1, which comes in direct contact, coming out soft so that it would allow itself, after it had been ground perfectly flat to be pened over at *L* so as to secure a perfect hold in the punch plate *B*. In the guide-plate *C* there are four tool-steel grub screws 7/16 inch diameter, 26 threads per inch and left a tight fit. These are hardened and tempered to take up wear caused through the die being ground on its broad face, they are locked by four 3/16-inch grub screws on top as shown in Fig. 1. This punch and die has sheared some 30,000 pieces and is good for many times that number. Between *C* and *D*, Fig. 1, the stock is fed between two strips of machine steel 3/32 inch thick that run the entire width of the face so as to guide the stock square to the shearing punch.

Feeding Stock Into the Shear Tool

In feeding stock, which by the way, measured 4⅝x0.255 inch thick, the stop *K*, Fig. 2, was set by means of the micrometer adjustment screw *J*, which has a thread 40 per inch cut on its entire length with its head graduated into 25 equal parts as shown in Fig. 1. By the aid of this micrometer adjustment I depend upon being able to procure a complete circle so far as practice would permit when the required number of laminations were built together. Now before I could proceed to cut up my stock it was most requisite that I should know exactly how many laminations I would require to make a diameter of 11/16 inch with two strengthening walls as shown in Fig. 10, each being 1/16 inch thick, given stock of 0.255 inch thick, so if I multiply by 22, which by the way, was the number of laminations needed of the thin gage = 0.255 × 22 = 5610 inches, so that with two outer or riveting walls, 1/16 inch thick = ⅛ inch, thus 0.5610 + 0.125 = 0.6860 inch, this proved to be all that was desired. The next point of interest to determine was the progressive differences that existed between laminations *A* to *R* shown at Fig. 10. I, therefore, sheared 22 pieces of *A* width, added the two strengthening walls *L*, riveted all together, turned them in the lathe the finished size, viz., 11/16-inch diameter. This done I took the whole of it asunder carefully numbering each lamination and then accurately measured the width of each lamination, which gave me the following results: *A* and *B* were alike, 0.687 inch; *C*, 0.677 inch; *D*, 0.665 inch; *E*, 0.652 inch; *F*, 0.635 inch; *G*, 0.605 inch; *H*, 0.573 inch; *L*, 0.540 inch; *J*, 503 inch; *K*, 0.452 inch; *L*, 0.3125 inch. So as to simplify matters in the regulation of the micrometer screw *J* on the stop *K*, I took the differences that existed between the laminations taken progressively. As laminations *A* and *B* are the same, I took their width as zero, so that the movement of the thumb screw I required to be as follows: *A* and *B* to *C* = 0.010 inch; *C* to *D*, 0.012 inch; *D* to *E*, 0.013 inch; *E* to *F*, 0.017 inch; *F* to *G*, 0.030 inch; *G* to *H*, 0.032 inch; *H* to *I*, 0.038 inch; *I* to *J*, 0.039 inch; *J* to *K*, 0.050 inch. To guard against mistakes in assembling, I had four assembling boxes made up of common wood with a sliding front as shown in Fig. 5, each of these boxes held sufficient laminations to make up 250 complete cores. There are twelve divisions, *A* to *L* inclusive. The sliding front completely shuts off one hole, this acts as a tell-tale showing where the assembler took the last lamination from. I used these boxes to guarantee that the different laminations were kept in their respective bins during the various operations.

The Piercing Punch

The piercing punch, Fig. 4, is made up with the same stock as the shearing tool, Fig. 1, with the exception of the top plate *C* which supports *C'*, and also prevents dirt and grit getting into the working parts of the self-centering chuck contained in the guide and stripper plate *C'*. Plate *C* is a piece of 4x¼x6½-inch bright-drawn steel. The self-centering device, shown more clearly in Fig. 8, consists of a piece of 4x⅝x6½-inch bright-drawn machine steel with two rectangular slot ways *T* 5x⅝ inch cut out to receive the two guides *K* which are of red brass machined all over with two ears on each *L*, which are drilled and tapped 3/16 inch Whitworth inserted in each ear. There are four studs which act as jaws of the chuck; these studs are made from 3/16-inch drill rod; they are threaded 3/16-inch Whitworth at one end, hardened and ground on the face at the other end; they are left a good fit in their bearings *L'* and locked from the underside by four ⅛-inch Whitworth grub-screws to prevent them from turning when set. These studs *L*, as shown at *N N* and *M M*, Fig. 6, part in the guide and stripper plate *C'* and part in the piercing die *D* through half circle slots cut through the face of the die, as shown at *M M* in Fig. 7. The two guides *K* carry the jaws *L* and are operated by the spindle *J*, Fig. 8. This spindle has a ⅜-inch Whitworth right-hand thread on one end and a ⅜-inch Whitworth left-hand thread on the other end, with a thrust bearing *O* that keeps it central; this spindle or double screw simply drops into position exactly in the same way as the average drill-chuck screw does. The guides *K* operated by the screw *J* are held in position by the four pilot pins *T* which are of 3/16-inch drill rod threaded at one end.

The Piercing Die

In laying out the piercing die, I had to exercise great care in marking off the punch holes *Q*, Fig. 4, as they had to be all the same distance apart, viz., 0.750 inch. The punch ways in the die are drilled larger at *Q*. The punch holes properly finished to 0.09375x¼ inch deep, the remaining part of the hole was drilled from the back of the die to ⅛ inch diameter. The same care had to be exercised in the hardening as in shearing die, Fig. 1. The punches *P* were made of drill rod riveted over at the top to prevent them from pulling through the punch plate *B*. They are hardened their entire length and drawn to a purple color and then dark straw at their cutting ends.

Feeding the Work in the Piercing Punch

The work is fed into the piercing punch at *V*, Fig. 4, between *X* and *W*. The width of *V* is 0.690 inch, which is 0.003 inch wider than the widest lamination that is to be pierced, and at the bottom there is a slot which permits of a knock-out plunger which is worked by a compound lever by the left foot of the operator and a similar contrivance for pushing the work home with the right foot, after being inserted by hand. The laminations 3 to 12, inclusively, required the use of the centering device; lamination *L*, Fig. 10, is 1/16 inch thick and consists of bright-drawn half-oval Swedish iron. The whole of the laminations were pierced at the rate of 1d. per 1500 laminations. As will be seen in Fig. 10, the work is held together by six brass rivets of No. 13 gage. Each of these rivets was headed at one end. Fig. 9 shows the tool employed for the riveting operation. It was made of ⅞-inch square tool steel, machined all over, carefully drilled to form the heads, the hole being about 0.003 inch smaller than the stock; this, aided by the keep

plate, as shown in both views, held the stock so that one blow with an 8-ounce hammer formed the required head. This tool is made for use in the ordinary parallel vise with lips, as shown, to prevent the tool from slipping. J. H. TURNER.

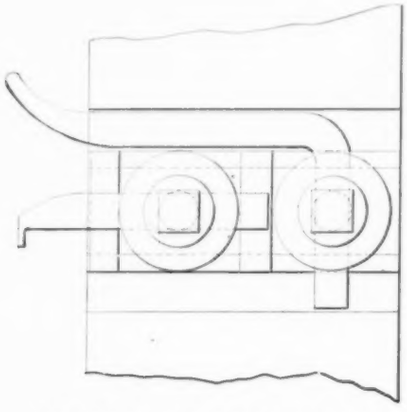
Birmingham, England.

Facing, Boring and Threading Rings

We had some cast-iron rings to make. Out of respect to Mr. Osborne's coffee mills and corn shellers, we will say they were to be used on a new sort of hay cutter we were getting up.

Exact sizes are immaterial, but they were to be about 3½ inches inside diameter, 4¾ inches outside, ¾ inch thick, and threaded internally with a square thread of seven pitch. One face, and the outside of the rings were left rough.

The work was done in a 16-inch lathe. Two tool posts were used, the one nearest the headstock holding an ordinary square-



THE BORING AND THREADING TOOLS

thread cutting tool, and the other a "special" round-nose tool, shaped as shown. In the tailstock, in place of the center, was a sizing tool, simply a taper shanked bar, carrying a double-ended cutter, 3½ inches long.

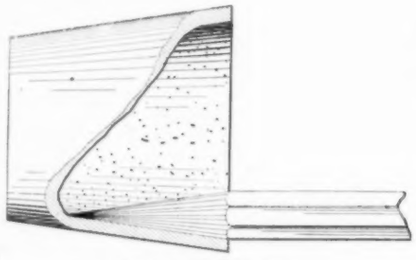
The method of operation necessitated that the universal chuck should be put on as securely as possible; then with the casting chucked, and the lathe running *backward*, the inside of the ring was roughed out leaving about 0.010 inch for the sizing tool to remove. The face was then finished, relieving it to a little greater diameter than the size of the thread, which, by the way, was much deeper than ordinary. With the lathe running forward the sizing tool was put through, and lastly the thread was cut, the ring being completed at one chucking, without change of tools in the tool posts.

Neither the traditions of the shop, nor the number of rings made at one time, warranted anything elaborate in the way of special equipment for the job, but it was thought that the method used was somewhat of an improvement over the more usual one of changing tools, and calipering for size. One bit of humor connected with the situation was that an apprentice managed to break seven threading tools in one-half day; this was held up to his successors as a limit which it would not be well to pass.

Stamford, Conn. C. N. H.

A Pencil Sharpener

To the many useful hints already described for the benefit of draftsmen I



PENCIL SHARPENER

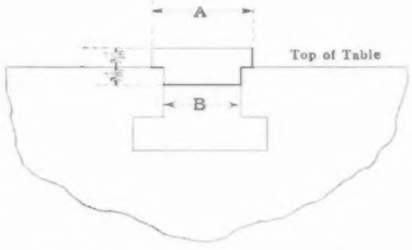
would like to add the one shown in the accompanying sketch. This provides for readily obtaining a fine round point on any drawing pencil.

Obtain a piece of material—either wood or metal—of the shape shown, and glue fine sandpaper on the inside surface. Then by keeping the cone stationary and describing a circle with the hand grasping the pencil which is held in the position shown, every part of the pencil point immediately comes in contact with the sand paper, resulting in a point as true and fine as could be desired.

Albany, N. Y. M. E. KEEL.

Standard Key Slots for Fixtures

I have found that the practice in most shops is to make new fixtures with a



STANDARD KEY SLOTS FOR FIXTURES

certain size fixed key, which ties a fixture up to a machine with certain width T-slot. This also makes it necessary for the tool designer to look up the machine on which a new fixture may be used and to find out the width of the slot in the table so that a key of proper size for the fixture may be determined.

In the accompanying sketch I have shown a key whereby this may be avoided, and which I think would be more convenient for both the drafting room and shop. And the choice of selecting a machine for a certain fixture may be left to the shop foreman to suit conditions at the time when he wants to use it.

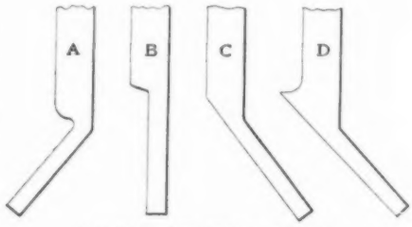
The key is made of tool steel and hardened. It is made a light press fit for both fixture and table, so that it may be easily removed. The width at *A* is always made to one certain size; one inch would be wide enough for ordinary use; the length is 1½ inches. The width of the key at *B* is made to fit the table slots of the various milling machines or planers.

Several sets of these keys may be kept in the various departments where they would be used. This method saves fitting each fixture with a certain size fixed key, and allows a fixture to be used on any machine to suit condition at the time it is put in use.

Revere, Mass. E. E. PHINNEY.

Making Key Drifts

Several years ago while the shop was shut I was changing some machinery. I



VARIOUS SHAPES OF DRIFTS

needed some key drifts, so went to a little blacksmith's shop where they did nothing much except shoe horses and repair plows. I expected to have to show the smith how to forge them, but he showed me something before he got through. He drew out the stock as at *B* the same as all tool dressers do. When he started to bend it I came near telling him he was wrong. Instead of bending it as most smiths do like *B* to get a heel that will go down into the keyseat he bent it the other way like *C*, then drew out the heel to go into the keyseat. When I came to use these drifts I found they did not bend up and break like the old ones did. A little thought showed me the cause.

In the old style *A* there is nothing to support the stock where the shoulder just above the heel is and the force of the blow causes it to bend. Afterward I was talking with him and explained why his drifts stood up to the work so well. He made one like *D* just to show what he could do. That smith is foreman of one of the largest blacksmith shops in this part of the country.

Decatur, Ill. W. A. BRIGHT.

Tapping Amber

A man brought a tobacco pipe in the shop to have the stem repaired. The stem was amber which had to be drilled and tapped. I tried several lubricants, but with everything I tried the amber would break after I cut about two threads. At last I tried alcohol and it worked fine.

Denver, Colo. H. G. BENTLY.

Jigs for Drilling Holes through a Round Pillar

Having a number of round pillars, as shown in Figs. 1 and 2, to drill, we designed the jig shown in Figs. 3 and 5, also in cross-section at Fig. 4. It possesses one point of interest to jig designers, that of clamping the pillar in two places with only one adjusting screw, *H*. This is a very excellent feature, and saves much time, and in my opinion, should be much more widely used in the design of jigs and clamping fixtures. Fig. 3 shows the general arrangement with a pillar in position. *A* is a gray iron casting planed on the bottom. *B B* are two V's for clamping the work in. *C* is a central bracket for carrying the clamping dog *G*, which is pivoted on the center pin *I*. *H* is the adjusting screw with a swiveling V, *K*, on the bottom end. The other end of the lever is made with a V in, to span the work as shown at *J*. When the clamping dog *H* is tightened it also forces the other end *J*, down on the work and secures it at both ends with equal pressure. *E* is a solid stop, to serve as a gage which can have an adjusting screw if necessary. *D D* are two brackets for carrying the drill bushings *F*. These are located exactly central over the two V's *B B*, so that whatever size the work, the bushings are always central; they are also interchangeable, to suit different sizes of work.

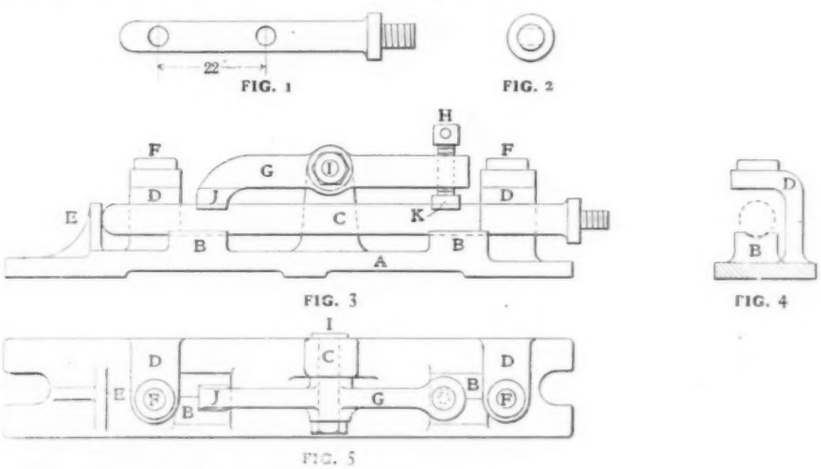


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5

JIG FOR DRILLING HOLES THROUGH ROUND PILLARS

London, England. J. GREEN.

Heat Treatment of Nickel Steel

It is a well known fact among engineers, that the nickel and chrome nickel steels require certain heat treatments to bring out their best qualities and increase their strengths before they are much superior to the common grades of high carbon steel. However, this is not realized by many who have had little experience in the matter, and the following striking example of what proper heat treatment will do in certain cases may be of some interest and possibly some service.

A well known automobile company found that the driving shafts in the rear axle of a certain new model, which were 1¼ inches diameter and some 34 inches long, showed up too weak to withstand the torsional stress and drive the car. The material specified was 3½ per cent. nickel steel with 20 to 25 points carbon and an analysis of borings from a shaft that failed proved that it was up to the specifications. As many shafts failed, a correct heat treatment of them was suggested and a set was selected and given the following treatment: They were heated to 1580 degrees Fahrenheit and quenched in cold water; then reheated to 460 or 470 degrees Fahrenheit and cooled in the atmosphere.

This set of shafts was put in the axle and given a very severe test, the loaded car being driven a long distance over muddy and hilly roads, after which an examination showed that they withstood the loads completely. Afterward all shafts were given this treatment and although many cars with these axles are running, no further trouble resulted which impressed all parties concerned with the necessity of treating the nickel steels to get satisfactory results with them.

Buffalo, N. Y. J. C. AUSTIN.

A Tool for Driving Tacks in Difficult Places

This tool is for use in placing small tacks, brads, etc., in position otherwise inaccessible and is made up of three parts as follows:

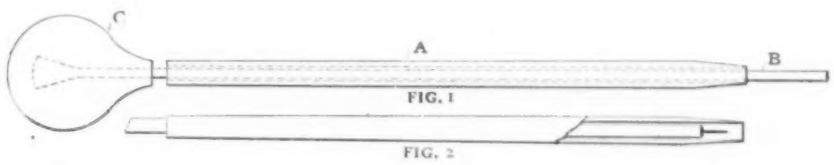


FIG. 1

FIG. 2

A TACK DRIVER

A is a brass tube, *B* a tool-steel plunger, *C* a knob or head which may be made of any available metal, preferably lead, babbitt, brass, etc., which can be easily molded. The tube *A* can be made any desired length and diameter and its bore should be just large enough to allow the rod or plunger *B* to slip in it easily.

The rod or plunger *B* should be made of tool steel with the striking end hardened and of sufficient length to allow about 1 inch to project beyond the tube *A*. The other end of rod *B* can be nicked or flattened so that when metal is poured around it for the knob there will be no danger of the rod pulling loose from the knob.

The plunger *B* should be magnetized which can be easily done by any one having access to a dynamo.

In using this tool it is simply necessary to pick up the small tack with the magnetized plunger *B*, draw it back into the tube *A*, place the tube *A* in the desired position and drive the tack, as the knob *A* has sufficient weight to very readily drive a good sized tack or brad.

Fig. 1 shows this tool assembled and Fig. 2 indicates its method of operation.

Springfield, Ohio. B. M. L.

Treatment for Blueprints which Show a Tendency to Fade

If it is found that blueprints from a certain lot of paper are prone to fade in sunlight or even in a strong light without being in direct sunlight the following remedy is recommended:

Expose the prints until badly burned and then wash in clear water until all the emulsion is removed. While still wet lay print with the blue side up on a smooth surface and by means of a paint brush, cover print smoothly with peroxide of

hydrogen. This will bring out the background very blue and the lines very white and make a print that will not fade to any extent in the sunshine.

Springfield, Ill. W. E. M.

Stops for Punch and Die Works

The stop *A*, Fig. 1, is a piece of drill rod beveled on the lower end, which rests on the top of the die, with a slot in the upper end to receive a light piano-wire spring *C* which is held in position on top of the stripper by the screw *D*.

The stock as it is pushed forward raises *A*, which, of course, drops into the pierced hole in the stock when it is reached, the stock is then drawn back against the stop.

The merits of this stop are; it obviates the necessity of a pilot in the large punch, with its endless troubles; accuracy and

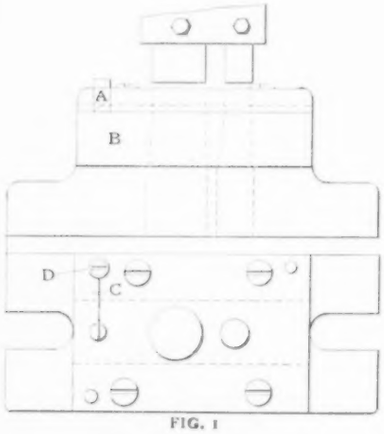


FIG. 1

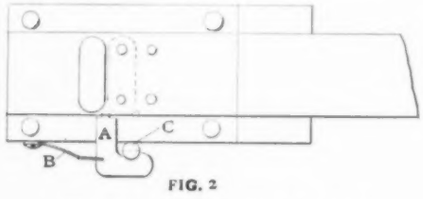


FIG. 2

STOPS FOR PUNCH AND DIE WORK

simplicity of construction; it can be applied to any shape of blank.

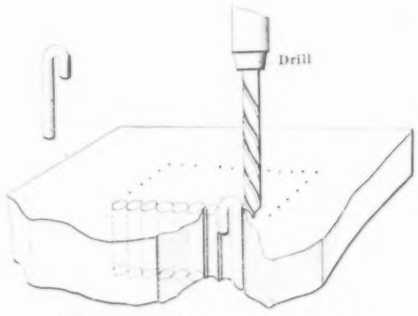
The stop *A* Fig. 2, which shows the underside of the stripper with the stock laid in, is a flat piece of stock fitted to the slot and held in position by a flat spring *B*. The stop is withdrawn from the stock by the pin *C*, which is carried in the punch holder, and is timed to withdraw the stop just before piercing takes place, allowing freedom to push the stock forward on the return stroke of the press.

This stop was designed to overcome difficulties in punching heavy soft stock such as copper, in which (owing to the thin wall rendered necessary by economy) considerable distortion takes place rendering a stop like Fig. 1 useless. This stop is simple of construction and can be operated very rapidly.

Houghton, Mich. A. HANTON.

Drilling Holes Close Together

Here is a simple device for drilling holes close together. Take a piece of steel wire the size of drill and bend the end over as shown, then lay out the work and drill two holes. Put the long end of pin in last hole and the short end in next to



DRILLING HOLES CLOSE TOGETHER

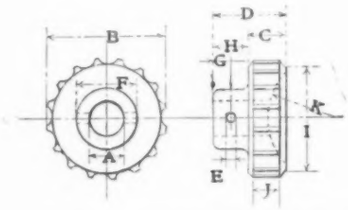
last hole. Allow the drill to follow down beside the pin, and when the holes are all drilled, you have the holes all connected and the piece drops out without any trouble or broken drills.

I make lots of dies and drill out the blanks but never break a drill and have no trouble getting the piece out.

Kennebunk, Me. WM. P. ALLISON.

Table of Standard Knob Sizes

Some time ago I was informed that the hand nuts I made were too fancy and cost too much. I got busy at once and the table shown will give you an idea of what was prescribed for future use. I think



A	B	C	D	E	F	G	H	I	J	K
3/16	1"	5/16	1/2	3/32	7/16	1/8	1/4	1 1/16	5/32	Cap Out to suit
1/4	1 5/16	5/16	11/16	1/8	9/16	5/32	5/16	1 5/16	1/4	
5/16	1 5/16	3/8	11/16	5/32	9/16	5/32	5/16	1 5/16	1/4	
3/8	1 5/8	3/8	3/4	1/8	11/16	3/16	3/8	1 5/8	5/16	
7/16	1 5/8	3/8	3/4	5/32	11/16	3/16	3/8	1 5/8	5/16	
1/2	1 3/4	3/8	1 1/16	5/32	3/4	1/4	1/2	1 5/8	5/16	
5/16	1 3/4	5/16	1 1/16	5/16	7/8	1/4	1/2	1 5/8	1/16	
5/8	2 3/4	1 1/16	1 1/4	5/16	1 1/16	5/32	5/16	2 5/16	5/8	
11/16	2 3/4	1 1/16	1 1/4	5/16	1 1/16	5/32	5/16	2 5/16	5/8	
3/4	2 3/4	1 1/16	1 1/4	5/16	1 1/16	5/32	5/16	2 5/16	5/8	

TABLE OF KNOB SIZES

everybody is satisfied as to cost and the workmen seem to prefer them to the rough nurled ones.

We have made a gate pattern of the various sizes as shown and have a drawer full in the toolroom at all times. They go on all our jigs that have hand nuts on too. They are made of cast iron and they are left in the rough with the exception of filing off the burs and giving them a little sweep of the emery cloth.

You will note they are called standard knobs but this is only a local standard for our own shop.

Syracuse, N. Y. M. J. HEDGLON.

A Gear-wheel Repair Job

We were hustling the hoist along at high pressure when a crack was seen in the large gear wheel, extending from the keyway through the boss as shown in Fig. 1.

After a look round we raked up an old coupling *C*, bored it and keyed it to the shaft. We then drilled the holes *h h* opposite in coupling and arm webs and bolted the wheel and coupling together. To take the shear off the bolts, hornplates *A* were bolted on every other arm, one only being shown.

When assembled and bolted up the coupling drove the wheel through the bolts and hornplates.

The job was quickly done, has had

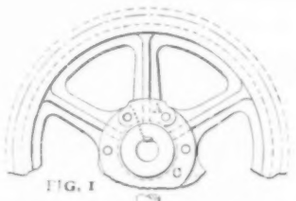


FIG. 1

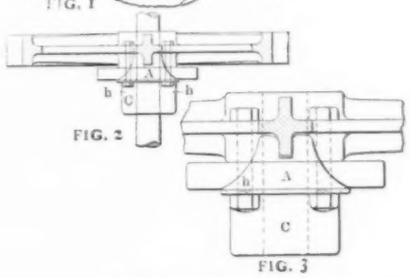


FIG. 2

FIG. 3

A GEAR WHEEL REPAIR

months of hard wear and is as good as new. Figs. 1 and 2 show general elevation and plan. Fig. 3 gives an enlarged view of the horn-plate connection.

London, England. H. LONDON.

The use of oil as fuel has engaged the attention of the British Admiralty for some time, and it has recently been decided to establish oil storage tanks in various parts of the United Kingdom to insure convenient sources of supply. Birkenhead, directly opposite Liverpool, has been selected as one of the supply centers. The experiments conducted by the Admiralty during the past twelve years were not at first satisfactory, and two adverse reports were made prior to 1902. Since then the tests have been of such a character as to reverse the original judgment of the Admiralty, and it may now be said that the importance of oil fuel is recognized by that body according to recent reports and that its use will be extended in the future as rapidly as possible.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

After I Have Served My Apprenticeship What Shall I Do?

Judging by the letters of Mr. Howk and Entropy on the article regarding what apprentices should do after serving their time, one saying that "the older men would not stand for it," and the other that a "kid will always be a kid in the old shop," they must think that it is out of the sphere of possibility for an apprentice to reach a good position in the old shop.

If the article conveyed the idea that every apprentice would ultimately become a foreman, either in the old shop or out of it, then someone ought to prod me lest I go to sleep again. But, note! The largest, wealthiest, most useful machine-tool building concern in the Central West has had practically no difficulty with their men. I was once or twice in their employ and can say that among their 700 to 800 employees I never met a more contented, intelligent, nor better paid shop organization in my 24 years' experience. The present superintendent was made a foreman before his apprenticeship had expired, the works manager, the assistant superintendent, the head draftsman, five foremen, four assistant foremen and six other foremen who quit and went into business for themselves, served their apprenticeship in the shop and were never, since they started to serve their apprenticeship, in the employ of any other concern. That doesn't sound as though an "apprentice has no chance in the old shop," that the "kid always would run to the boss for instructions," and "the older men would not put up with it." All of the above mentioned officials served in their capacities between the ages of 19 and 27 years down to the present moment. During their administration the shop grew from a small institution to its present size. I can call attention to at least 10 other shops with a similar record. If you read the AMERICAN MACHINIST advertisements you would easily recognize every one of them.

Yet I want it understood that I have no wish to even intimate that this is the only way to get good foremen. I appreciate broad experience as much as Mr. Howk or Entropy. In the days of specialization why not specialize on your superintendents and foremen?

The concern that I refer to above made several foremen from apprentice material last year. If you want to go outside of the machine-tool industry, just think of the United States Steel Corporation. Again some of the leading technical schools have their own students for instructors.

Cleveland, Ohio. J. G. DORNBIRER.

Circular Beams

On page 905, Vol. 31, Part 1 Con Wise gives an ingenious attempt at a solution of a problem for circular beams. It seems to me that he has made an error in the statement that e in the formula,

$$PR\,\frac{(1-\cos.\theta)}{2}=\frac{P_s I_p}{e},$$

is the distance from the neutral axis to the top or bottom fiber. I believe e should

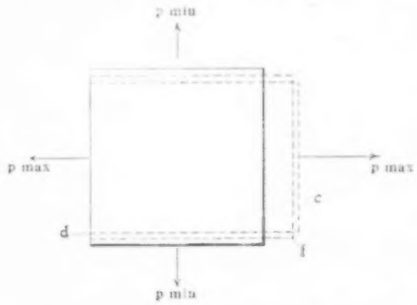


FIG. 1. DIAGRAM ILLUSTRATING DISTORTION OF A CUBE

be the distance from the center to the extreme fiber, or ½ the diagonal of the bar, as this is the polar moment I_p. I am not able to follow all of his formulas and I offer the following as an attempt at a solution: You will see that the result obtained differs considerably from that obtained by Con Wise. The notation is the same.

The bending moment $=\frac{Pa}{4}$; the twisting moment $=\frac{Pb}{2}$; the equivalent bending moment $=$

$$M_e=\frac{Pa}{8}+\tfrac{1}{2}\sqrt{\frac{P^2a^2}{16}+\frac{P^2b^2}{4}},$$

since

$$M_e=\frac{M}{2}+\tfrac{1}{2}\sqrt{M^2+T^2},$$

Then, the moment of resistance $=$

$$\tfrac{1}{6}fbh^2=M_e=\frac{Pa}{8}+\sqrt{\frac{P^2a^2}{16}+\frac{P^2b^2}{4}}.$$

Let

$f=16{,}000$, $b=1$ inch, $h=4$ inches,

$$a=R\ \sin.\theta,\quad b=R\ (1-\cos.\theta).$$

Then

$$\tfrac{1}{6}fbh^2=\frac{PR}{4}\left\{\frac{\sin.\theta}{2}+\sqrt{\frac{\sin^2\theta}{4}+(1-\cos.\theta)^2}\right\}.$$

For the particular problem, $\theta=45$ degrees, $P=2370$ pounds, after solving for R we get 88.6 inches instead of 31 inches as obtained by Con Wise.

Stillwater, Okla. R. E. CHANDLER.

[Mr. Chander's letter was referred to Con Wise and his reply is printed below. —ED.]

With regard to the criticisms of Professor Chandler, which, by the way, reached me on the day that the new star went on our flag for Oklahoma, I wish to say that so far as I know there is no good theoretical reason why we should take e, in the formula referred to, as either the half diagonal or the half diameter. Experiments on rectangular cross-sections have shown that the cross-section which was a plane before twisting does not remain a plane after twisting. Now the whole theory of twisting beams or shafts depends on the cross-section remaining a plane. Experiment has also indicated, as can be found in any text book on mechanics, that with a square shaft the fibers most strained are at the center of the sides of the shaft rather than at the corners. Since there appears to be nothing definitely known about the correct value of e it seemed to me best to use the easiest value, and take care of any discrepancy in the factor of safety.

My "Tech" boy on whom I depend for this kind of work objected that this was no way to do it, but if we waited till these theorists got it all worked out we would never get our trolleys up.

Now for the second criticism. Professor Chandler has taken the formula for combined bending and twisting

$$M_e=\frac{M}{2}+\tfrac{1}{2}\sqrt{M^2+T^2},$$

which is applicable only to *round* shafts, as the following will show.

Taking my formula

$$p_{max.}=\frac{p}{2}\pm\tfrac{1}{2}\sqrt{4\,p_s^2+p^2},\quad(1)$$

p is the fiber stress, tension or compression, due to bending; p_s is the fiber stress, shear, due to torsion.

$$M_{bending} = \frac{p\,I}{e},$$

and for a round beam =

$$\frac{p\,\pi\,r^3}{4},\ p = \frac{4\,M}{\pi\,r^3}, \qquad (2)$$

$$T_{torsion} = \frac{p_s\,I_p}{e},$$

and for a round beam =

$$\frac{p_s\,\pi\,r^3}{2},\ p_s = \frac{2\,T}{\pi\,r^3}. \qquad (3)$$

Substituting (2) and (3) in (1)

$$p_{max.} = \frac{4\,M}{2\,\pi\,r^3} \pm \tfrac{1}{2}\sqrt{\frac{16\,T^2}{\pi^2\,r^6} + \frac{16\,M^2}{\pi^2\,r^6}} \qquad (4)$$

$$= \frac{2}{\pi\,r^3}\left(M \pm \sqrt{T^2 + M^2}\right).$$

Multiply by $\frac{\pi\,r^3}{4}$,

$$\frac{p_{max.}\,\pi\,r^3}{4} = \tfrac{1}{2}\left(M \pm \sqrt{T^2 + M^2}\right) \qquad (5)$$

$$= M_{max.} \text{ or } M_e,$$

as Professor Chandler states it, except that there is a $\pm$ sign, the plus sign giving a maximum value and the minus sign giving a minimum value. That is, my formula gives two principal stresses acting at right angles to each other.

Now when a piece of elastic material is acted on by two normal stresses at right angles the effect on it is different from that due to either stress alone. For example in Fig. 1 let $p_{max.}$ and $p_{min.}$ act on a unit cube as shown. The $p_{max.}$ stretches the cube horizontally to c and at the same time decreases its vertical dimension to d. The vertical force $p_{min.}$ now applied tends to lengthen the original cube vertically but decreases the length horizontally to f so that the final horizontal dimension is less than would be due to $p_{max.}$ alone by an amount equal to $\frac{1}{m}$ of the stretch vertically due to $p_{min.}$ This accounts for my equation

$$p_e = p_{max.} - \frac{1}{m}\,p_{min.} \qquad (6)$$

Of course, if $p_{max.}$ is tension and $p_{min.}$ is compression then the sign in (6) should be plus.

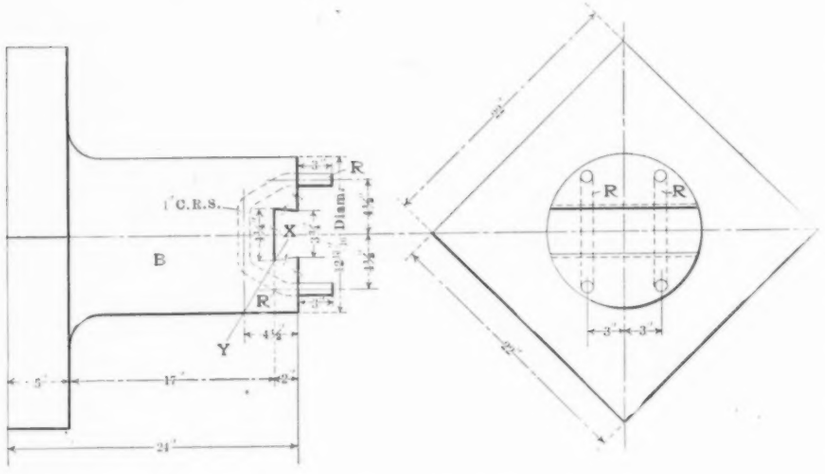
I hope this will help Professor Chandler to follow my work.

Worcester, Mass. CON WISE.

Casting Steel Rods in Iron

I have read with considerable interest the article by O. James concerning "Casting One Metal on or in Another," on page 20, of the AMERICAN MACHINIST.

We have recently had some experience regarding this same matter and this fact makes the subject doubly interesting to me.



CASTING STEEL RODS IN IRON TO STRENGTHEN IT

The bases to our steam hammers, of which one is shown in the accompanying cut at B, caused us a great deal of annoyance by breaking across at the top on the line $X\,Y$ when subjected to heavy duty.

To remedy this we tried the stunt of casting two reinforcement rods in the top of the base, as indicated in the cut at $R\,R$, with results that were very gratifying.

The reinforcement rods R were made of 1-inch round cold-rolled steel. After they were forged into shape they were taken to the sand-blast machine and given a good scouring under the blast. This cleaned them thoroughly and left a slightly roughened surface with no rust or scale, which seems to be just the thing for the molten cast iron to fuse to.

The ends of the rods R were left 3 inches longer than necessary. These projecting ends were stuck into the sand of the mold which supported them as it would cores. When the casting was taken to the planer to be machined these ends were cut off. The cast iron and the cold-rolled steel seemed to be fused together perfectly as in one piece and the base was greatly strengthened thereby, the extra strength coming right at the point where it was most needed.

We were greatly pleased with the result of the experiment. The base is now in constant use, and, as yet, shows no signs of breaking.

Washington, D. C. R. B. LOVEJOY.

Hand Turning Operations in the Lathe

Before replying to several statements made by Mr. Lomas in his article on page 938, Vol. 31, Part 1, I may state that I spent 13 years in Yorkshire and other parts of England engaged on different classes of machine work. I have been over the ground mentioned by him, Oldham, Rockdale, Accrington, Manchester and other towns in Lancashire, and Halifax, Lowerby Bridge, and Keighley in Yorkshire. I have been through the mill with regard to hand turning as a damaged left hand testifies, but for all this I fail to see where there is such a broad field in machine building establishments for the "hand lathe tools."

In some cases they make a fair showing, where the main thing is to get off the scale and get a polished finish with no particular accuracy or quality, but even then the turning is only one operation; the boring is another and separate one.

In connection with this class of work Mr. Lomas and his associates, with their business ability and knowledge of English, American and continental machinery, should have done some hard thinking along the lines of special grinding machines. These get off the scale and leave a smooth, finished surface without the use of emery cloth, oil, and a polishing stick. It would be a blessing to the boys who are doing hand work to get rid of this dirty method of finishing cast iron.

Referring to paragraph on "Workman Selects His Own Tools" why do intelligent engineers use the ordinary engine lathe or hand lathe to produce such work as handles, knobs, pins, etc.—articles with curves and fillets—when there are such machines as forming machines, and turret lathes for the use of circular forming tools. These produce such work accurately and in a tithe of the time taken by a hand turner.

This statement also applies to small shafts, studs and screws.

With regard to truing up cast gear teeth on top, with the bastard file reversed; that is done in all countries where it is deemed necessary, but it is after all only for appearance and is really unnecessary. Where I serve my time this was done at first on small bevel gears about 5/16-inch circular pitch and about 4-inch diameter but afterward it was cut out. The gears run just

as well; the taps of the teeth do not engage.

I cannot see why a hand tool should outplace a machine tool, and certainly the machine work will be more uniform.

It is, of course, a well known fact that the Lancashire textile-machinery makers produce very cheap machinery by the older methods. Yet I firmly believe that it could be beaten by the methods of today and a better product would result. As a comparison, take a German reproduction of the Singer sewing machine, which sells to the public at 40s. or $10. How much hand work is there done on its strictly interchangeable parts, cut cams and gears of steel, hardened and ground studs and shafts and general elegant finish?

With regard to the wage question I believe hand turners who are years out of their time are only earning from 22s. to 24s. ($5.50 to $6) per week. Of course, there may be a few cases where they earn up to 32s., but this is the limit. These men have to be very expert with their hand tools. Compare these figures with the wages earned by American lathe hands, $2.50 to $3.50 per day. The wage ratio is about $3 to $1.

If it were possible for the heads of some of these Lancashire and Yorkshire firms, which are, I believe, the most conservative mechanical engineers on earth, to come over here to learn mechanical matters, they might be induced to alter their views as to which methods and systems of machine making are most profitable. I believe that when the present-day users of batteries of hand turning machines or lathes, will give the turret lathe and automatic manufacturing machines a fair chance. WM. L. WEBSTER.

South Berkeley, Cal.

An Indexing Die and Indexing Cutters for Grinding

In addition to the many new ideas which we see illustrated and described in the AMERICAN MACHINIST, there are many articles that serve to remind us of our own struggles with similar difficulties.

On page 946, Vol. 31, Part 1, under the title "An Index Die for Automatic Punchings," is an article that takes me back to a Chicago shop where I worked in 1899. We had a lot of 24-tooth bicycle sprockets to make, and the contract price was so low that it was absolutely necessary that the usual time and labor record be broken. These sprockets were to be made of scrap pieces of boiler plate, 3/16 inch thick. We already had round blanking dies of the proper size, and the sprocket was lightened by three rows of punched holes for which we also had dies that would do. All that remained was to devise a quick way to form the teeth, which were of the cycloidal type.

We had two Lincoln milling machines, but not only were these overcrowded with work, but the cost of milling was too great, even if the teeth were merely finished. To make a punch and die to stamp out all the teeth at once, was out of the question for several reasons. So a punch and die was made that would cut two of the spaces between the teeth at once. One punch roughed out; the other trimmed.

A 24-tooth ratchet index plate, about two inches smaller in diameter than the sprocket, was made and arranged so that a sprocket blank could be quickly fastened to it by a bolt passing through the centers of both. A nut held the blank, while a pin passing through one of the punched holes insured its not slipping. The die and index plate attachment were mounted on an old bed plate in such a way that the rim of the sprocket passed over the die face in the correct position. A strong spring dog engaged the teeth of the index wheel and completed the outfit.

After once set, 900 sprockets were finished on this arrangement. Thirty-two had to be scrapped; the rest passed inspection. About one-half of the spoiled ones were ruined because the operator failed to hold the index tooth against the end of the dog. The actual cost was figured at about half that of milling, counting die and all. Some would have put on a positive lock instead of merely a ratchet wheel and dog, but it was better to spoil a few than to use a thing that would be slower to operate.

INDEXING GEAR CUTTERS WHEN GRINDING

This also brings me to the indexing device, used for grinding gear cutters shown on page 17. In this device the lock, as shown, is too slow of operation, for in cutter grinding only light cuts should be taken on each tooth in turn; in consequence a dog would be better.

However, in our cutter-grinding practice we use a fixture that allows the cutter to be laid flat and indexed entirely from the back of the tooth. The error in this method is certainly not more, I believe it is less, than in using any index wheel or plate. It is certainly simpler and quicker, and another advantage is that it is much easier to grind the cutters truly radial.

For instance, we use a saucer wheel and a straight-edge laid across the face is a quick and certain means of lining-up the table parallel, as well as getting the center of the cutter in line with the cutting edge of wheel. Then, if the tooth rest is fed in, and not the table, the grinding is correct. In the fixture just cited no provision is made to keep the cut radial except by twisting the whole thing on the center at each revolution.

I am a firm believer in using the back of the tooth to index by and can't see the use of using anything else. We use enough cutters to keep one man doing nothing but that class of grinding. Though we have two indexing devices, they are never used on our regular work.

Sometimes we get an emergency reamer to sharpen. These reamers are usually made of odd pieces of round tool steel with a tapering square ground on one end. As it is impossible to index by this square, and our grinder chucks are all three jawed, we usually wedge on some lathe gears the teeth of which are divisible by four and, with a stop fastened to the table, index the reamer. The shank is held in a universal chuck. This method is usually accurate enough for all practical purposes. ETHAN VIALL.

Decatur, Ill.

Factors in Germany's Industrial Activity

Recently these columns have been thrown open for the discussion of the growing problem of training competent labor, with some references to German methods. That excellent but too brief article by Mr. Auerbacker, on page 678, Volume 31, Part 1, has tempted me to write something on the subject. It has been my privilege to spend the past five years in wandering about the continent of Europe, in the course of business in the interests of an American labor-saving machine. More than one-half of that period has been spent in Germany, which, by the way, is some indication of her enterprise in adopting modern methods and appliances when compared with other European nations. During that five years I have watched with interest and admiration the progress of a people who are bound to take the first place in industry in the near future. I have noted the rapid growth of Germany's beautiful and well ordered cities and of her industrial factories and technical colleges; and have watched the exercise and effect of her wise and sensible laws. I have lived among an artisan class who are sober in habit, courteous in disposition, and who are industrious, well educated and intelligent.

EFFECTS OF LAWS THAT ARE PATERNALISTIC

The government of the country is nothing if not paternal, and some of her domestic laws would seem tyrannical to Englishmen or Americans, yet to the German they are not so. Even the much maligned police supervision laws have a distinct value, for they make the existence of the tramp or hobo impossible. In contrast, Americans are proud of an excess of freedom which allows roads and public gardens to be littered with degenerates who can only exist at the expense of the industrious. Mr. Auerbacker has told us how the German government assists the manufacturers in many ways: by cheap and efficient rail service without preferential rates, by facilities for communication at a low cost and by the automatic employers' liability law. There is also an

excellent poor-law administration, which does not give aid indiscriminately, neither does it pauperize or degrade, and the well known contributory and subsidized old-age pension scheme.

Germany's Commendable Educational System

All these measures of the Government are commendable, but it is the laws in regard to education which are responsible for the "greater average efficiency of her workmen," as one writer puts it. These laws are so stringently enforced that none but the veriest weakling can escape 12 years of elementary and continuous schooling. The advantages of science in the form of monthly medical inspections are utilized for the physical well-being of children. Defective children have special instruction, and are taught in open-air schools. All schooling and school books are free, and physical drills and gymnastics are enforced. For the poorest children food is provided; sometimes by private benevolence, but always under state control. There is every evidence that the German likes education for its own sake, so that the stringent compulsory law is not unpopular. He is probably the best educated, or the least illiterate, of the average member of any nationality. If you pass the public schools on a Sunday morning you may see the ambitious artisan in the neighborhood with his books or his drawing instruments under his arm. Most of the office and sales force of factories are linguists. An English friend of mine in Berlin has 350 pupils for evening lessons in the English language. There are many other English teachers in the same city. From this it must not be inferred that the German is in the habit of burning the midnight oil; as a rule, he never forgets his café and his social glass of beer in the evening.

From what I have gathered from the former correspondence on this subject, it is a lack of higher mental power, or rather a dearth of men possessing it, which is being felt so keenly in America. It will be generally recognized that the engineering trades of today demand a higher degree of education than was formerly the case. Now this higher mental power is rarely found except in combination with physical fitness; even if it should be so discovered, it would be of little use in the strenuous life of the engineer. It is here that the German has, and will have for some time, the advantage of Americans. The German long ago grasped the idea that a nation's industrial welfare is founded to a great extent on its children's stomachs; to that end he set his house in order. There may be found abject poverty alongside of great and superfluous wealth, but to their honor as a nation be it said, this poverty is not evidenced in the condition of the children, even in this time of depressed trade and general privation.

Continuation and Apprentice Types of Schools

At 14 the German working-class boy leaves the day school and is apprenticed to a trade for four years. He usually serves the first year without any remuneration, and is paid in the succeeding years according to ability. He has been turned out from school with a good elementary education and with a body as physically fit as medical science and careful nurturing can insure. For another four years he must attend continuation schools and is still subject to discipline. At 18 he is free for a time from state control, but at 20 years of age the army takes him in hand and remodels him if necessary. Thus we see his physical fitness is automatically cared for and insured. Many of the leading manufacturers have established their own continuation schools which are for the use of the apprentices they employ. In these cases the youth is absolved from the necessity of attending the public schools, but the employer is made responsible for his regular attendance. The apprentices usually leave off work at four in the afternoon and go to a classroom; here they are taken in hand by teachers chosen from the technical staff of the firm, who give them instruction in the higher principles of mathematics and mechanics relative to the work they have been doing in the shops. The youths appreciate these factory schools as of more direct interest than the public ones. The fact that the German boy holds his job is no doubt due to a national characteristic and to his early training. He has been more subject to and is more amenable to discipline, both parental and otherwise, than the American boy.

Quality of Work and Relative Value of Wages

Mr. Auerbacker compares the speed of the German workman with that of his American brother to the former's disadvantage; though there may be something in it, he has apparently forgotten "German thoroughness." My experience has been, and I have worked in all three countries, that the limits of accuracy are finer in Germany than in either England or America. This somewhat limits the output. At the same time I am not commending this, and often think that this sometimes unnecessary accuracy must seriously limit the margin of profit. The speed of a workman is in some respects relative to the incentive given and the trust he can repose in the honesty and fair dealing of those who employ him. I have yet to learn that the German-American is behind in the country of his adoption. Trade statistics are dry reading and none are given here, but they are easily accessible to those sufficiently interested. A perusal of them will display some startling facts in the steadily growing influence of German exports, especially in machinery, and incidentally the falling off of British and American trade to that country. Many people are under the impression that cut prices and a low wage rate are responsible for this; but this is only partly so; the very appearance of the people is against it; for in no country in the world is there less visible poverty displayed in industrial centers than in Germany. The thrifty habits of the German may account for this to a large extent as they do for his greater efficiency. I have made it my business to inquire into the wage rate paid in many parts of the German empire, and the average for machinists is as follows: In Brandenburg, Wurtenberg, Westphalia, and Silesia, 16 cents per hour; Bavaria and Saxony, 12 cents per hour; in the textile-machine factories in remote Alsace, 8 cents per hour. These rates are, of course, much lower than are paid in America, but are equal to the average British rate if we except Alsace. It should be stated that these wages are on the up-grade, and the number of hours of labor is steadily lessening. As an instance of direct and successful competition, a firm in the province of Baden pays an average rate of 17 cents per hour, makes agricultural machinery and successfully competes with British and American firms in both home and foreign markets. The British firms pay an average rate of 13 cents per hour. The success is due to a modern plant, strenuous enterprise and a highly educated staff. The point in Germany's favor is, as she is a new industrial country, the advantage of a more modern and, therefore, more productive manufacturing plant. Outside of this all the success she has met with is due to the cultivation of industrial intelligence, much hard work and exercise of common sense.

The Duty of the State

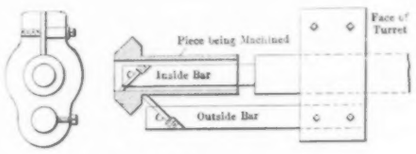
The German public continuation schools are classified into various departments or subjects to suit students who are learning various trades or professions, on the same lines as prevail in technical schools in England, and probably similar ones in America. The greatest difference is that they are entirely free, but attendance at them is enforced by law. This latter fact will be unpalatable to the Englishman or American with their questionable ideas of the freedom of the individual. Industrial opinions aside, the illiterates of a race of people are a physical and moral danger to a state; the foundation of industrial training schools is only a palliative of the present evil; it was conceived by a minority of interested manufacturers, for this they deserve every credit, but they are doing that which it is the bounden duty of the State to do in any country, after the physical and mental education of its subjects has been first seen to.

H. Englander.

Coventry, England.

Boring and Turning Bar

On page 899 our friend W. Osborne writes on "The Evolution of the Boring Bar." I should like to continue and tell how we use one on the outside diameter. The job which prompted the tool was a bevel pinion made on a 4¼-inch Cleveland, and called for a cut from 3⅝ to 1¾ inches and 5 inches long on one cut



BORING AND TURNING BAR

and drilling a 1¼-inch hole at the same time. The machine would pull all right, but the tool dulled often and took time to set, also the price run out more than was allowed. There were no spare holes in the turret, so that any other kind of a finishing cut could not be considered. The illustration will show the bar and clamp. The latter was fastened to the shank of the boring bar proper, and a cut of 1/32 inch taken. If the work ran out both hole and outside diameter were concentric and after the piece was cut off we had no further trouble. The cost of the tool was about $5, and paid for itself in one week.

Fairfield, Conn. W. I. FRANCIS.

Repair of Wheel Centers

The article by H. L. Burrhus on the above subject, on page 14, is very interesting, not only from the oddity of such work, but the manner of doing it, and at the same time showing the wide field of subjects the AMERICAN MACHINIST handles and puts before its readers. Having done such work myself I can appreciate the difficulties of getting a perfect weld in close quarters, but we gained the same end in a somewhat different manner, with equally good and rapid results, and I believe with less trouble than Mr. Burrhus' method.

Of course it is sometimes difficult to weld iron to cast steel, but the secret of this is in the flux and iron used for this purpose. In the first place it is well known by most smiths that the best grades of Norway iron will weld at a much lower heat than ordinary iron, and where the flux, already spoken of, is used intelligently the heat is held to a remarkable degree. This flux is simple to prepare, and a pinch on a welding heat gives very good results. To prepare it use an old fry-pan or plate shaped like one, fill it full of raw borax, then place on the fire and reduce it to a liquid by slow heat. When brought to this stage pour it on a flat plate and let it cool. This will give a greenish-black substance resembling glass. It should then be reduced to fine powder which makes it ready to use.

To prepare for the weld in the wheel center spoke a V is cut out on each side of the crack, as shown in Fig. 1, and a 1-inch tapered punch driven down through the center to make a ¾-inch hole. Having a norway-iron pin in readiness, this is fullered and spread over the inner surfaces of the V's, which gives an iron bottom and part of the V's to weld to. The V blocks are of slightly less taper than the V's in the spoke, and are rounded at the bottom, as shown in Fig. 2. The bottom, therefore, comes in contact first and is

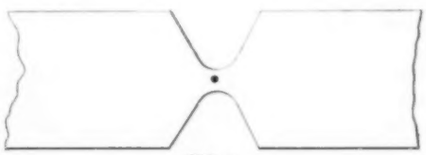


FIG. 1

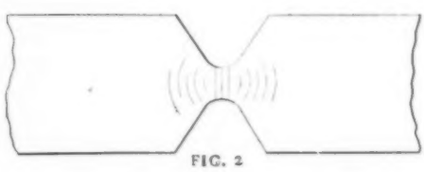


FIG. 2

REPAIRING WHEEL CENTERS

sure to weld tightly to the plug. These are also made considerably larger so they can be spread and leave plenty of stock to hammer on. The surplus stock can easily be removed afterward with a chisel.

In welding these V's in place the spoke is heated to a low welding heat, but the V-block is heated as high as possible. Then just before being put together the weld joint is sprinkled lightly with the flux, which instantly runs over the hot surfaces and seems to raise the heat instead of lowering it as so many other preparations do.

We generally weld these pieces in with two flogging hammers with short handles, as they can be handled quickly, and it is possible to get in closer places than with ordinary sledges. After trimming off and smoothing up the first side, the other side is put through the same operations. This gives a job that can always be depended on and has the merit of being more simple than that described by Mr. Burrhus, as the norway-iron pin takes the place of the strips welded on each side of the crack; it leaves the bottom solidly welded on both heats, and the tops can then be reheated and worked on should it be necessary. The norway iron being so soft and easily spread it generally takes hold on all sides if handled quickly and vim is put in the hammer strokes.

St. Louis, Mo. T. TOOT.

Answer to Geometrical Problem

The construction in the accompanying half-tone gives the solution requested by Mr. Lockwood on page 61.

Using his notation, the problem is as follows:

Given the point O and the three positions OB, OC, and OD of an arm of known length swinging about O.

Given the point Q and the angles b and c.

Required the length of the arm QR and the length of the link BR.

The solution is as follows: Draw QB and QC as in Fig. 2. With center Q and with radius QB draw the indefinite arc BB_1 with the same center, and with radius QC draw the indefinite arc CC_1. Lay off the angle BQB_1 equal to the given angle c, and lay off the angle CQC_1 equal to the given angle b. Find the center T of a circle passing through the three points B_1, C_1 and D. Then QT is the required length of arm, and DT is the required length of link.

Proof: Imagine the broken line B_1TQ to represent a rigid member. Rotate it around Q until B_1 reaches B, and T reaches R. As every point on this member must rotate through the same angle, it follows that angle TQR equals angle B_1QB. But as we made this latter angle equal to c, it follows that angle TQR is equal to c.

In a similar manner it may be proved

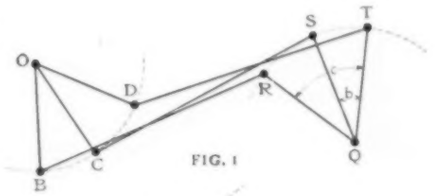


FIG. 1

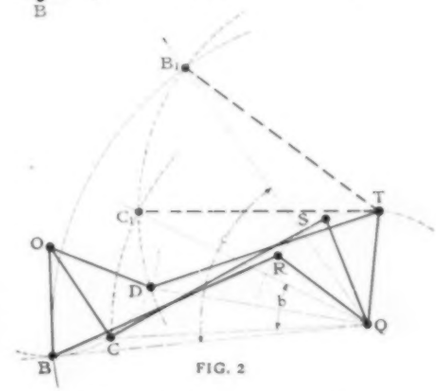


FIG. 2

SOLUTION OF PROBLEM ON PAGE 61

that angle TQS, equal to angle C_1QC is equal to angle b thus showing that the given conditions have been complied with.

Montclair, N. J. EDGAR H. BERRY.

The board of directors has approved the project for the erection, at a cost of $50,000, of the first building for the Mexican National Exposition at Puebla to be held in 1910.

AMERICAN MACHINIST

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Aug. 6..... 33,000
Aug. 13..... 19,000

This paper reaches 33,000 *separate readers each month and* 19,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Engineering Research—An Excellent Use for Public Money

A few months ago renewed interest was aroused in the engineering research work of the Engineering Experiment Station of the University of Illinois by the installation of Professor Goss as Dean of the College of Engineering. We have frequently reviewed bulletins of this Station with pleasure and appreciation, and it is surely fitting to point out the value of such research work, and to call attention to the opportunity presented to other States of the Union to make a similar use of public money, in establishing stations for experimental research along broad, engineering lines.

In 1903 the Legislature of the State of Illinois, by an unanimous vote, appropriated the sum of $150,000 for the College of Engineering of the State University. Upon receiving this appropriation the Board of Trustees established the Engineering Experiment Station. Its purpose was thus set forth: "It is the purpose of the Station to carry on investigations along various lines of engineering and to study problems of importance to professional engineers and to the manufacturing, railway, mining, constructional and industrial interests of the State." Two years later the legislature approved of the work thus started by a second appropriation of $150,000. These appropriations were wisely made and have been wisely administered; for experience has proven that money spent in scientific research in aid of industrial development is returned many fold in increased production.

The results of the investigations were intended, primarily, to aid the industries of Illinois, yet their benefits have gone far beyond State boundaries. Bulletins have been issued dealing with such subjects as tests of reinforced-concrete members, tests of high-speed tool steel, holding power of railroad spikes, tests on Illinois coals, strength of chain links, tests of a liquid air plant, and settlement and weight of crushed stone. Work has been done in the provinces of civil, mechanical, electrical, railway and architectural engineering. It is impossible to estimate the value of such scientific research work in engineering lines. Great discoveries are not stumbled upon. They come as the result of hard, patient work. The chance selection of a spot for a miner's grave gave to his partner one of the largest nuggets of gold that the world has ever seen, but the enormous stores of gold that are in the possession of this generation are the result of scientific investigations of mining methods.

We are beginning to look with apprehension upon the industrial strides of Germany. What is the principal factor in this phenomenal advance? This principal factor is undoubtedly the research work of German scientists and technologists. How much of our own industrial prosperity of the last 10 years has been due to the engineering graduates of our technical schools? This question cannot be satisfactorily answered, but it is a fact that our engineers and technologists have been in the forefront of our industrial progress, and the knowledge that they have brought to bear upon manufacturing problems came from engineering research.

On the 30th day of June of this year a monument was unveiled at Trenton, N. J., to a famous engineer, John A. Roebling. He is best remembered as the designer of the Roebling bridge, or more commonly called, Brooklyn bridge. This bridge, which was planned from research work of his own, was so well calculated and constructed that although today it is loaded several times heavier than he estimated, it is reported to be safe and unhurt. Compare this record with the lamentable Quebec bridge disaster of a few months ago. The member that gave way first and precipitated the crash was only taxed to about two-thirds of the load that it was designed to carry normally, and engineers now understand that the designs were based on assumptions unsupported by experimental data. How paltry is the sum of money that would have paid for all necessary experimental research in connection with those members, even although that sum should have covered the cost of a testing machine far larger than any the world has yet seen. Such an amount, whatever it might have been, is not to be compared with the loss of 74 lives and the discredit thrown upon American engineering.

A happier illustration of the value of scientific research could not be mentioned than the growth of the use of reinforced concrete as a material of construction. Ten years ago concrete was used only for foundation work, or in large masses. Today it is employed for all classes of superstructure work, even to ornate details. The production of portland cement during that period has increased some twenty fold. These results have been brought about largely through intelligent research work with cements, with methods and materials for reinforcing, and in regard to the properties of reinforced-concrete members. No less than eight of the 23 bulletins of the Engineering Experiment Station of the University of Illinois deal with some problem in the use of concrete.

As is natural and right, the work of this station is intended to aid directly the industries of the State of Illinois. That it is of vastly broader application, we do not need to point out. Why should Illinois be left to enjoy these honors alone? Can a better use be found for a reasonable proportion of the public funds than in

intelligent engineering research that is of direct value to the industries of the State? Here is an opportunity for the technical and manufacturing interests of each State to make a direct appeal for the appropriation and administration of suitable funds for engineering research work. The results for good will be incalculable. In addition to aiding the industries of the State, good will be accomplished by the inspiration of engineering students, in the broadening of teachers of engineering and through a larger heritage for posterity by furnishing data to aid the conservation of our natural resources.

Harris Tabor

Harris Tabor, founder of the Tabor Manufacturing Company, and for recent years acting in the capacity of its consulting engineer, died at his apartments in Philadelphia, on July 29, 1908.

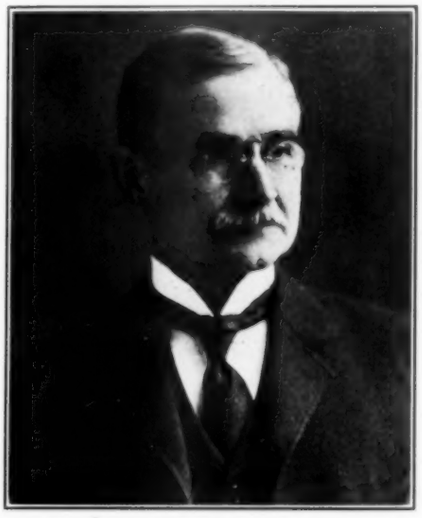
Mr. Tabor's death is attributed to the result of an automobile accident with which he met a little over a year ago while driving along a narrow hillside road in New Jersey. Heavy rains left the road in poor condition, and the earth slipping from under the wheels, due to the weight of the machine threw his machine over an embankment. Mr. Tabor was pinned under the machine, and on arrival of medical assistance, summoned by his wife, who was accompanying him on the trip, it was found he had sustained serious injuries. He appeared to show gradual improvement, however, until during the month of March he contracted a cold, which coming on him in a weakened condition, became a serious illness and resulted in his untimely death.

Mr. Tabor was born in Clarence, Erie County, N. Y., January 26, 1843. Here he received a common school education and showed early signs of rare mechanical and inventive ability. He was of a studious disposition, and gave promise of exceptional attainments.

On May 16, 1861, at the age of 18, he enlisted in the 23d Regiment of New York Volunteer Infantry for a term of two years, at the end of which period he was honorably discharged and mustered out of service at Elmira, N. Y.

Two years previous to his enlistment he had begun his mechanical training as an apprentice in the shop of his brother, Leroy Tabor, Sr., at Tioga, Penn. After his discharge from the army he entered the employ of S. Payne, at Troy, Penn., as a machinist. His next position was with B. W. Payne & Sons, Corning, N. Y., and on removal of this concern to Elmira he was made superintendent. For a year in the early 80's he was at Hartford, Conn., acting as superintendent of the Hartford Steam Engine Company, leaving for Pittsburg to accept a similar position for the Westinghouse Machine Company, with which company he remained about three years.

Up to this time, Mr. Tabor's work had been confined to steam engineering lines, and he had invented and placed on the market a steam engine indicator and a throttle governor. While in the service of the Westinghouse Machine Company he conceived the idea of a power operable molding machine, which came to him as a result of observations he had been making in the foundry. Recognizing the commercial value of a machine of this type, he associated himself with Manning, Maxwell & Moore, under an agreement which called for their assistance in developing, perfecting and marketing the molding machine. He took up quarters in New York, so that he might give his entire attention to the development of his molding machine. For three years from



HARRIS TABOR

1885 he experimented with and built molding machines and in 1888 produced and placed on the market the first successful power molding machine, operated by steam, with a cylinder overhead. In the fall of 1888 the manufacture of the machine was taken up by the Pond Tool Works, Plainfield, N. J. In the early 90's the Tabor Manufacturing Company was organized and transferred the manufacture of the machines to S. F. Moore Sons Company, Elizabeth, N. J. It was here that the vibrator molding machine was brought out and the first molding machine operated by compressed air produced.

In 1900, Mr. Tabor sold the greater portion of his interest in the company to Wilfred Lewis and the plant was transferred to Philadelphia. From 1900 to 1906 Mr. Tabor was engaged in looking after various interests and acting as consulting engineer to his company, having relinquished the presidency on the disposal of his larger holdings. In 1906 he took up residence in Philadelphia, and from then on to the time of his death took an active interest in the affairs of his company.

National Machine Tool Builders Association's Annual Convention

Announcement is made of the regular annual convention of this association, which is to take place on October 20 and 21, in New York City, with the Hotel Imperial, Broadway and Thirty-second street, as headquarters.

New Publications

HERSTELLUNG DER ZAHNRADER. By Eduard Linsel. 77 4¼x6⅛-inch pages, and 39 illustrations. Verlag der Administration der Fachzeitschrift (der Mechaniker). Price, 1.5 marks.

This little book is well written, but from a theoretical standpoint. Thirty-two pages, or about one-half of the total, are given up to a discussion of the theories of odontics. We then find a section treating of the various types of curves that are used for tooth outlines, and the balance of the book shows the application of these curves. There is very little material which could be grasped by the designer as of direct help to him in laying out gears. One illustration, Fig. 33, is of interest, as showing a pair of bevels with herringbone teeth.

Personals *

W. E. Farrell has been elected president of the Stoever Foundry and Manufacturing Company, Myerstown, Penn., succeeding Ralph McCarty, recently resigned.

Frederick D. Mackay, second vice-president of the E. W. Bliss Company, sailed on August 4 for a business trip in Europe. Mr. Mackay expects to remain abroad about six weeks.

Ed. R. Euston has been elected vice-president and general sales manager of the Stoever Foundry and Manufacturing Company. Mr. Euston was formerly New York manager of this company, in which capacity he has acted for the past six years.

A. T. Nickerson has recently associated himself with the engineering force of W. S. Barstow & Co., with headquarters at New York. Mr. Nickerson will be remembered as a contributor to these columns, and, prior to his present connection, was with the Stone & Webster Engineering Corporation.

Rodman Gilder, who has been connected with the Crocker-Wheeler company, of Ampere, N. J., for some time, and until recently was active head of their publicity department, has been elected secretary of the company. Mr. Gilder has been closely interested in the Technical Publicity Association, in which he has been an office-holder since its inception.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Push-button Lamp Socket

The illustration shows the ingenious mechanism of this socket so well that little description is necessary. There are only three moving parts, as shown in Fig.

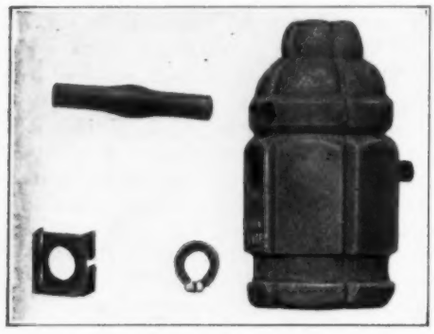


FIG. 1. A SIMPLE "PUSH" LAMP SOCKET

1, consisting of the push bar, coil steel spring and the moving contact piece which goes over the push bar, as can be seen in Fig. 2. The coil spring is held in a recess of the contact piece and, referring to Fig. 2, if the push bar is pressed to the left, the coil spring rides up on the cone or incline until it passes the largest diameter, when the tension of the spring immediately moves the attached piece to the right, and breaks the connection. A reverse movement of the push bar throws the contact piece in the opposite direction, and the whole mechanism is exceedingly simple and effective.

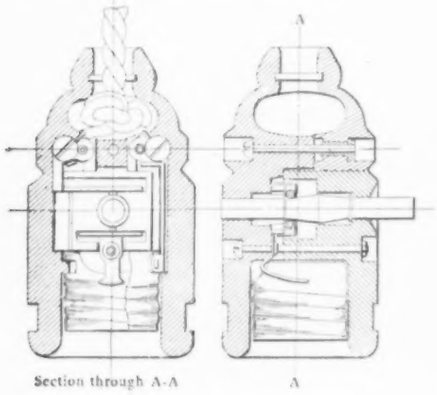


FIG. 2. THE SOCKET DETAILS

It has been found that the tungsten and tantalum filaments are more fragile than the ordinary carbon filament, and are occasionally broken by the jar caused by the use of key sockets. This is probably aggravated by the tilting of the lamp out of its normal position in the act of turning the key and then allowing it to suddenly fall back into position on releasing the hand. This is, of course, entirely obviated with a socket of this kind.

As shown in both views, this lamp socket is made of porcelain and held together by screws. The same mechanism is applied in pendant and other switches. This is being made by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

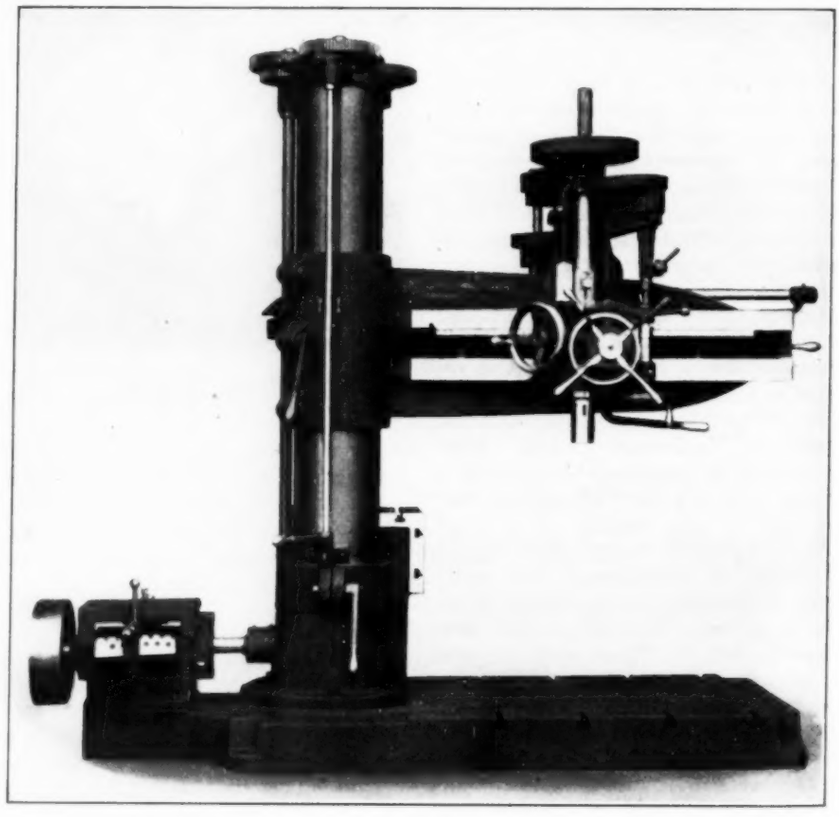
A New 48-inch Radial Drill

Several improvements have been introduced in the new radial drills of the Dreses Machine Tool Company, Cincinnati, Ohio, the machine itself being seen in Fig. 1 and the details in Figs. 2, 3 and 4.

The spindle sleeve is now made of bar steel and the bearings are lined with phosphor bronze bushings. The rack is cut directly on the sleeve which brings the pressure close to the center and allows a perfectly round hole to be bored and reamed into the headstock for the sleeve, which is impossible when intersected by a groove for the rack.

The quick return has four operative levers, each engaging and disengaging the feed instantly, while a locking plug keeps it disengaged when fed by hand or when tapping. The construction of this quick return is the same as they have used for several years.

The feed has four changes and is operated by the little handle shown on the worm shaft by means of a rack and receding key. It is of the all-geared type, but a frictional connection is interposed, yielding just before the breaking point of the weakest gear. The lever shown below the arm stops, starts and reverses the spindle by means of a friction clutch. The so-called back gears are on the rear of the headstock and are engaged and disengaged by the handle shown at the left-hand side of the head, while the machine is running. The elevating device of the arm is so designed that the gears are idle when not in use.



IMPROVED 48-INCH RADIAL DRILL

The construction of the inner and outer column is shown in Fig. 2. It will be noticed that the clamping band *A* grips

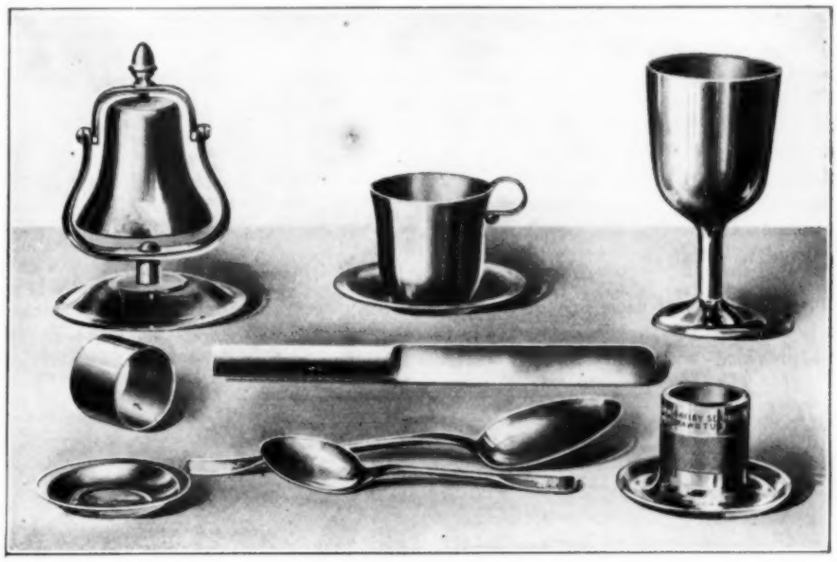
both inner and outer column, but exerts no pressure on the top of the anti-friction bearing. A large and small roller alternate so that there is no friction between them.

The speed variator allows the machine to run always at the slowest speed when making the changes so as to reduce the momentum. The principal construction was published in this paper some years ago, but a new simple and effective "overtake" clutch has been introduced. In Figs. 3 and 4 the gear *B* runs loose on the variable speed shaft, but is clutched by four pawls *P P P P* located in the fixed gears *C*. These pawls are kept in contact with the inner surface of gear *B* by the spiral springs *S* and by clearing the faces *b* to about 5/16 inch they will clutch the gear *B* to gear *C* when run in the direction of the arrow, but will release when *C* runs faster than *B*. It was found that the faces *b* of the pawls must be made very carefully, as when cleared too small they make dents on the inner face of the gear *B* and when left too wide they will not clutch at all.

All the high-speed bearings on this machine are lined with removable phosphor-bronze bushes, all the bevel gears and pinions below 6 inches are of bar or forged steel. It will be noticed that simplicity has been an object in the design, but without missing any of the modern features for rapid production. All gears which could possibly be dangerous to the operator have been thoroughly incased.

Possibilities of Steel Tubing

The tools or appliances shown are part of a large set made for use at a banquet given to the officials of the National Tube Company to show what can be done with the Shelby seamless steel tubing. These



ARTICLES MADE OF SEAMLESS DRAWN STEEL TUBE

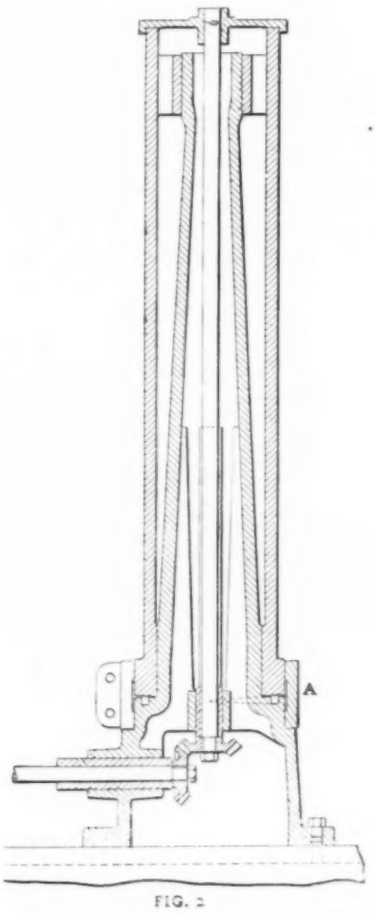


FIG. 2

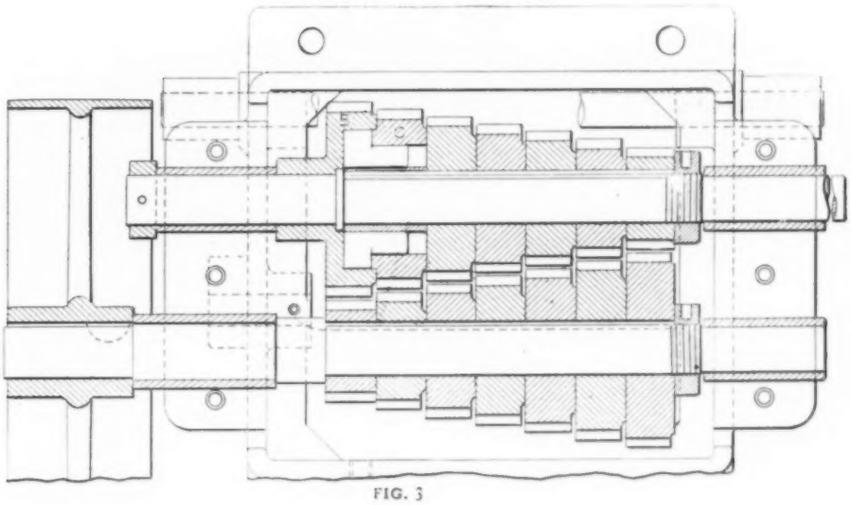


FIG. 3

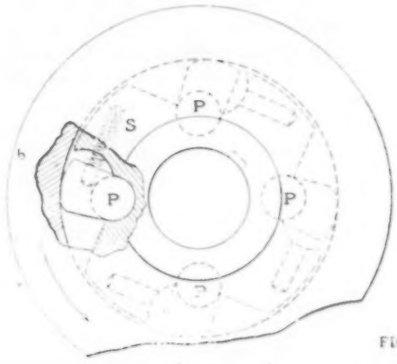
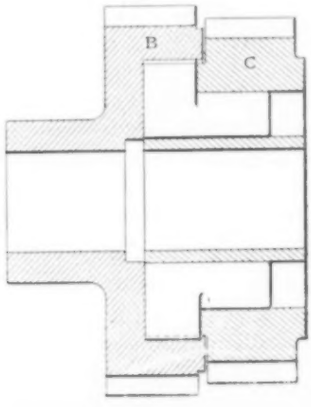


FIG. 4



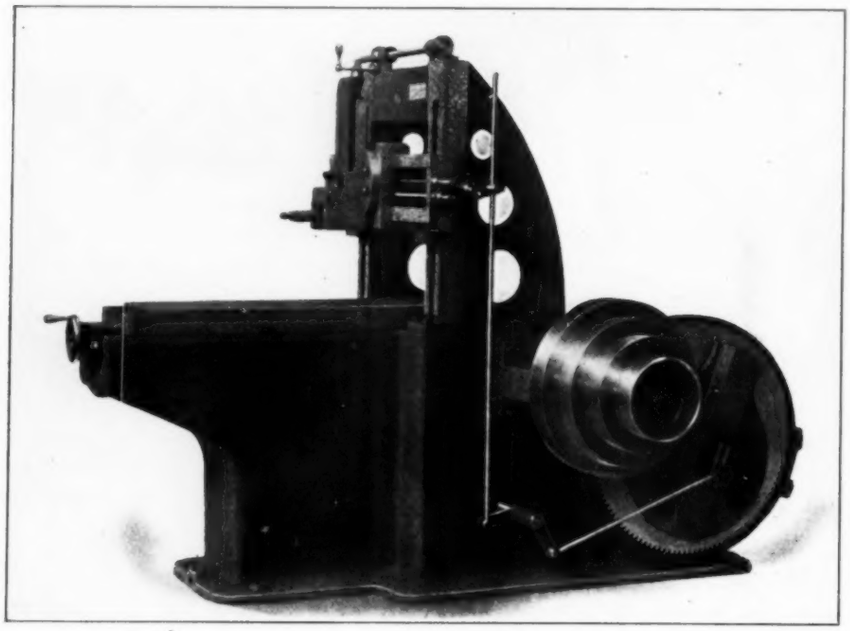
DETAILS OF THE DRESES RADIAL DRILL

articles were all formed by different manipulations of the tubing and show how it can be drawn, reduced, flanged or hammered flat at will. It makes a very interesting exhibit and presents the evidence in a way not to be easily forgotten.

A 24-inch Crank Planer

This is a very substantial machine with massive bed, housings and cross-rail and is designed for heavy duty. The table is driven by positive crank motion of the Whitworth type so as to secure a quick return. The stroke is adjustable by a removable crank wrench, and the position in relation to the bed can be changed by the hand wheel at the end of table while in motion.

The head swivels each side of the verticals and is graduated in degrees. It is also provided with a micrometer collar



HEAVY 24-INCH CRANK PLANER

reading to thousandths. The table has large bearing surfaces on top of the bed and is gibbed its entire length to take care of any upward thrust.

The machine will plane 20 inches high and the same width, and has a 24-inch stroke. The table is 46 inches long by 16 inches wide, and the head has a feed of 9 inches. It weighs 5500 pounds, and is made by the Cincinnati Shaper Company, Cincinnati, Ohio.

Saws Which Revolve the Stock Being Cut

Messrs. John Holroyd & Co., Milnrow, England, call our attention to the fact that they have built hack saws for some years in which the stock is revolved while being cut. In stating on page 999, Vol. 31, Part 1, that the saw there described differed from others in this respect we had in mind the American market, as there is also a German cold saw having a similar device.

A New Barium Chloride Gas Furnace

By P. F. Reichhelm

In heating high-speed steel for hardening, a barium-chloride bath offers all the advantages obtained from a lead bath, and to this is added the advantage of the barium chloride forming a coating on the steel while it is being transferred from the heating bath to the quenching bath. This prevents the metal from becoming oxidized, by keeping it from coming in contact with the oxygen in the air. It also volatilizes at a much higher temperature than lead, or any of the other materials used for heating baths and, therefore, is successfully used for the high temperatures that are needed to harden high-speed steels.

As pieces heated in this bath have the temperature raised evenly, and at the same time, on all sides or exposed parts, it overcomes, to a very great extent, the tendency of warping or distortion which all steels have.

While barium chloride forms a coating on the steel heated in it, this coating usually peels off when suddenly cooled in the quenching bath, and any which might cling to the metal, is easily brushed off, or it can be jarred off by hitting the tool a sharp rap. This is also considerable of an advantage over the lead, or other baths, used for heating steel, as frequently spots of lead adhere to the steel and are difficult to remove.

These good qualities have caused the American Gas Furnace Company, of 24 John street, New York, to build a furnace that is specially adapted to the heating of the barium-chloride bath. This furnace, with the burners and gas connections, is shown in Fig. 1, while a sectional view of the furnace is shown by Fig. 2.

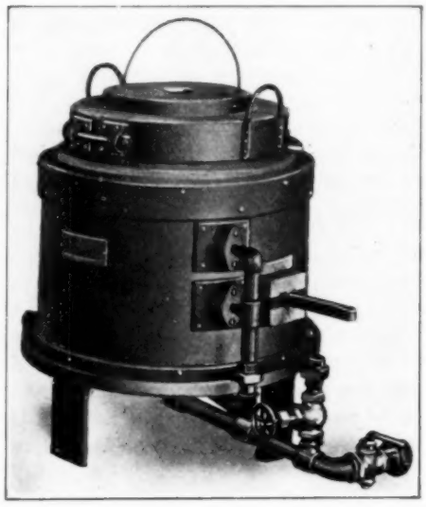


FIG. 1. CRUCIBLE GAS FURNACE FOR BARIUM CHLORIDE

The furnace is composed of a sheet-metal shell *A* that is lined with a special firebrick *B* to withstand the high temperatures that are required. A No. 40 Dixon's black-lead crucible is used in the furnace shown, but furnaces are made to fit any size of crucible desired.

After the crucible is set in the furnace, the top *C*, which fits close to the crucible, is placed on. This top is made of the same special firebrick that forms the lining of the furnace, and it is held together by a sheet-metal band with two

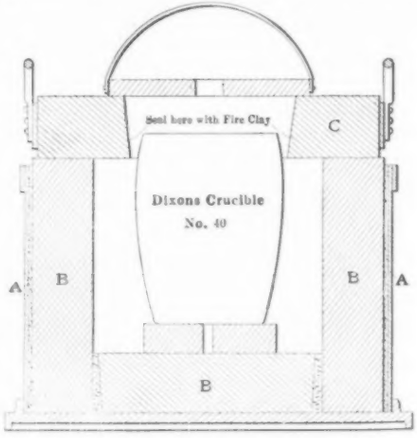


FIG. 2. SECTIONAL VIEW OF FURNACE

lugs and a clamping nut, as shown in Fig. 1. This band is provided with two handles to make it easily movable when the crucible burns out and it is necessary to take this out and insert a new one. The opening between the furnace top and the crucible should be sealed with fireclay to prevent the gas flames from attacking the

barium chloride in the crucible, as this causes unnecessary fumes that are almost unbearable, to come from the bath.

A cover *D* is also provided with the furnace, and this is made of the same firebrick, with a metal band around it that is supplied with a handle so it can be easily lifted on and off. In the center of the cover is a small hole for the purpose of giving vent to the bath.

The gas is sent into the furnace at an angle, as this gives the flame a rotary motion that will create an even heat on all sides of the crucible, in the furnace chamber. The exhaust opening is placed at the side of the gas inlet, and as close to it as possible, so the gas will make the complete circuit of the furnace chamber. This opening is supplied with a firebrick plug, with a handle on it, so the loss of heat will be small and the gas used be reduced to a minimum.

The required temperatures of from 1900 to 2200 degrees Fahrenheit, are readily obtained with a blast under a pressure of 1¼ pounds to the square inch. Gas and air valves are used with the burners that give a perfect control of the supply and this enables the correct temperature to be obtained and then maintained for any length of time.

Work of large dimensions may be preheated in an oven furnace to bring it up to an annealing heat, as this will greatly facilitate the work of the barium-chloride bath and increase its capacity while smaller work, such as taps, reamers, drills, etc., need not be pre-heated owing to their heating quickly.

The illustrations show the No. 36 cylindrical hardening furnace which is the correct size for the No. 40 Dixon crucible.

Industrial Education in Extreme West

In Portland, Oregon, the Board of Education announces that at the beginning of the school year in September there will be established, under the direction of the Board, the Portland School of Trades. The object of this school will be to furnish instruction to the boys of Portland in some trade that they may be better fitted for their life work. Opportunity will be given for instruction in the following trades: Carpentry, cabinet making, pattern making, molding, electrical construction, machine-shop practice, mechanical and architectural drafting and plumbing. Such academic branches as English, mathematics, applied physics and electricity, and industrial chemistry will be included in the course. Special attention will be given to these subjects as they relate to or have bearing on the trade work. The course will be three years. The equipment will cost nearly $20,000.

Business Items

The constantly increasing trade of The S. Obermayer Company, in and around Erie, Penn., has made it necessary for them to open a branch warehouse in that city. W. L. Scott is in charge

The Stoever Foundry and Manufacturing Company, Lebanon, Penn., has recently elected new officials and the new administration has effected arrangements so that all sales in the future will be handled through the New York office at 140 Cedar street.

Trade Catalogs

Zeh & Hahnemann Company, Newark, N. J. Booklet of power presses. Illustrated, 12 pages, 4x9 inches, paper.

R. I. V. Company, 1771 Broadway, New York. Catalog of radial bearings and ball thrust collar bearings. Illustrated, 16 pages, 6x9 inches, paper.

Northwestern Expanded Metal Company, Old Colony Building, Chicago, Ill. Pamphlet giving information on expanded metal. 10 pages, 3½x6 inches.

The Carborundum Company, Niagara Falls, N. Y. Catalog describing carborundum and carborundum wheels. Illustrated, 124 pages, 6½x9 inches, paper.

The Park Drop Forge Company, Cleveland, Ohio. Short Stories About Steel No. 4, on Benjamin Huntsman, inventor of crucible steel. Illustrated, 4½x7 inches, paper.

Garden City Fan Company, Fisher Building, Chicago, Ill. Bulletin No. 40 illustrating and describing steel plate cycloidal shavings exhausters. 4 pages, 6x9 inches.

Northern Engineering Works, Detroit, Mich. Booklet No. 24 showing electric traveling cranes, hand power cranes, etc.; also electric hoists. 32 pages, 3½x5½ inches, paper.

Business Opportunities

Mayo & Son, Foxcroft, Me., will erect a new woolen mill.

Burke & Gregory, Norfolk, Va., will build a $25,000 printing plant.

The Lagonda Box Company, Springfield, Ohio, will erect a new factory.

G. A. Kelly Plow Company, Longview, Texas, will increase capacity of its plant.

The Phillips Sheet and Tinplate Company, Parksburg, W. Va., will enlarge plant.

The Star Watch Case Company, Ludington, Mich., is building additions to its plant.

The Straubel Machine Company, Depere, Wis., contemplates building a new plant.

The Virginia Can Company, Buchanan, Va., has had plans prepared for factory building.

Bancroft, Ross & Sinclair Company, New Orleans, La., will establish a pattern factory.

The Musgrave Fence Company, Des Moines, Iowa, will erect a new building to cost $75,000.

Fire destroyed foundry No. 1 of the E. J. Jones Company, Boston, Mass. Loss, about $150,000.

R. F. Struthers, Peoria, Ill., manufacturing wire fence, gates, iron posts, etc., will locate in Omaha.

The Southern Pacific Railway Company will soon begin the erection of car shops at Colton, Cal.

The National Machinery Company, Tiffin, Ohio, is having plans made for the remodeling of its plant.

The Mesta Machine Company, Pittsburg, Penn., has increased its capital stock and will extend plant.

Contracts have been let by the Great Falls (Mont.) Iron Works for the erection of new machine shops.

Virginia Can Company, Buchanan, Va., has had plans prepared for a factory building to cost about $20,000.

The J. Nelson Manufacturing Company, Beaver Dam, Wis., will erect a foundry in North Milwaukee.

The G. A. Kelly Plough Company, Longview, Texas, is preparing to enlarge the capacity of its plant, it is said.

It is reported that the National Scale Company, of Beaver Falls, Penn., will probably move to Chicopee, Mass.

The Pittsburg (Penn.) Steel Company has commenced work on a $1,000,000 addition to its plant at Monessen, Penn.

The Menominee (Mich.) & Marietta Light and Traction Company will build a $500,000 power house at Grand Rapids.

The Eagle Casting Company, Winchester, Ky., has increased its capital stock and will make improvements to plant.

The Baxter Stove Works, Louisville, Ky., has been organized to manufacture small collapsible stoves. R. Wise, president.

Reidsville (N. C.) Paper Box Company, a new concern, will erect plant, which will have a capacity of about 3000 boxes a day.

The Reliance Textile and Dye Works, Covington, Ky., has purchased a site at Lockland, O., on which it is proposed to erect a plant.

The William Skinner Manufacturing Company, Holyoke, Mass., will erect a new four story silk mill, also a power plant and coal pocket.

W. H. Rogers, of Birmingham, Ala., will establish plant at Houston, Texas, for the manufacture of sheet-iron articles and paint.

The Twin City Boiler and Sheet Iron Works, Bristol, Tenn., has been incorporated, and will erect plant. Offices are at 304 Eighth street.

The Chesapeake & Ohio Railroad Company will erect a shop at St. Albans, W. Va. The general offices of the company are in Richmond, Va.

Cramp & Company, of Philadelphia, are estimating on plans for a new car barn for the Third Avenue Railway Company, New York.

The Engineering Company, Fort Wayne, Ind., has been incorporated with $30,000 capital to manufacture structural and ornamental iron tanks, boilers and to do a general foundry business. The directors are Otto Gustave and Robert Bengs.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

Small, accurate drill jigs and dies built to order. R. Rosner, Madison, Wis.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Castings, prints, 8-inch screw-cutting foot lathe. W. Morey, 2563 Trink St., Chicago, Ill.

High power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—Machinery or machine parts to build by contract. Ideas developed; drawings made. Address "A," care AMER. MACH.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Which company have on stock or build special machinery for manufacturing horseshoe nails? Address full offers to T. M. Apstein & Sons, Kiew, Russia, Kresczatik No. 2.

A large mercantile corporation in a large western city is offering some preferred stock. It is a conservative and safe investment. Full particulars on request. Box 355, AM. MACH.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris streets, New York City.

A large concern manufacturing centrifugal pumps desires to secure reputable machinery houses to act as agents on commission basis in the following cities; Baltimore, Washington, Hartford, Providence, Boston, Portland, Maine; Harrisburg, Pa., and Rochester. Communicate at once to Box 339, AMERICAN MACHINIST.

How to Find a Market in Germany—If you wish to sell any complicated machinery, such as crushing, grinding, drying, conveying plant, etc., which an ordinary commercial agent cannot sell, you need an experienced engineer, who knows how to adapt your apparatus to the local requirements of these various industries. Send me full particulars. Edgar A. Volkersen, 61 Maria Louisenstrasse, Mamburg 20, Germany.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

High grade superintendent wants good position. Up in recent shop methods in all departments and cost systems. Energetic, executive, a handler of help and a producer. Box 349, AMERICAN MACHINIST.

Position as superintendent; 12 years' experience as superintendent and assistant; excellent executive ability; expert designer of tools, fixtures and special machinery; specialty light high grade interchangeable work. Box 345, AMERICAN MACHINIST.

ILLINOIS

Designing draftsman on machine tools and shop equipment. Box 378, AMER. MACHINIST.

Practical and technical man with experience on machine tools and presses, shears and dies for sheet metal. Box 379, AMER. MACHINIST.

Designer of machine tools, 8 years' shop practice, 6 years' drafting room experience, desires change. Box 373, AMER. MACHINIST.

Young man, age 37, wide experience in the manufacturing of agricultural machinery or hardware. Expert draftsman and pattern maker. Design molding machines, jigs, fixtures and dies. Can handle men. Executive ability, assistant superintendent or foreman. Box 368, AMERICAN MACHINIST.

MASSACHUSETTS

Draftsman and designer, practical mechanic, technical education, wide experience. Box 375, AMERICAN MACHINIST.

Practical machinist tool and die maker, experienced foreman and inspector, age 40, married, open for engagement. Box 365, AMERICAN MACHINIST.

MISSOURI

Position Wanted—Chief draftsman with 10 years' experience in electrical and mechanical lines, desires change. Has held present position over three years. Executive position preferred. Will go anywhere Box 380, AM. MA.

NEW JERSEY

Mechanical draftsman wishes position. Address Box 374, AMERICAN MACHINIST.

A mechanical engineer, chief draftsman and designer, of executive ability and experience, desires engagement. Box 358, AM. MACH.

Experienced, capable mechanical draftsman, age 28, technical graduate, desires change at $21.00 to start. A. Werner, 228 Clark Place, Elizabeth, N. J.

Mechanical engineer, 28, open for engagement. Five years' practical experience in the design and construction of condensers, pumps, heaters, etc.; also erection of Corliss engines. Two years' designing, erecting and estimating pipe work for large power plants. Shop, drafting room and business experience, executive ability. Box 369, AMERICAN MACHINIST.

NEW YORK

Thoroughly experienced mechanical superintendent desires change. Address Box 357, AMERICAN MACHINIST.

Position as superintendent manufacturing hardware, sheet metal goods or drop forgings. Address "Competent," AMERICAN MACHINIST.

Expert wants position to invent, design or improve automatic or special machinery, large or small. Present connections in New York and Pittsburg. Address Box 377, AMER. MACH.

Wanted—Mechanical superintendency. One of the live ones, up to the minute in modern shop practice. Any location. Ready for engagement at once. Box 337, AMERICAN MACHINIST.

High grade designer, 12 years' all-round experience, steam turbines, steam engines, special machinery, automatic machinery, wishes position where originality and utility count. Box 372, AMERICAN MACHINIST.

Superintendent or general foreman, age 40. Twenty years' experience. Expert on pumping machinery, steam, gas and gasolene engines, modern routing, system, discipline, harmony. Rapid production a specialty. Advocates piece work and premium work. Introduces either. Has reference. Box 370, AMER. MACHINIST.

NORTH CAROLINA

Engineer, 12 years' experience shop and drafting room, in steam, gas, power and electric machine. For last three years chief draftsman. First-class designer. Desire to change. Box 381, AMERICAN MACHINIST.

PENNSYLVANIA

Expert cost accountant and systematizer desires an executive connection with manufacturing concern. Up-to-date methods and satisfactory results guaranteed. Box 304, AMERICAN MACHINIST.

Expert on premium system, modern production, task work in general desires change. Thirty-three years old, 17 years' experience, strong personality, initiative, capable of handling large bodies of men, time and money saver. Results guaranteed. Box 364, AMER. MACH.

WISCONSIN

Position as superintendent by a high grade practical man. Organizer, systematizer, executive. Box 299, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

INDIANA

Wanted—An experienced foreman for machine shop manufacturing gasolene motors. Address Box 334, AMERICAN MACHINIST.

Wanted—Several first-class tool makers on jig and fixture work for automobile parts. Call or write Nordyke & Marmon Co., Indianapolis, Ind.

MASSACHUSETTS

Machinist wanted with experience as toolmaker and foreman Golding Mfg. Co., Franklin, Mass.

First-class mechanical designer for electrical and mechanical instruments wanted in manufacturing establishment in Massachusetts. State age, education, past experience and salary expected Address Box 356, AMER. MACH.

NEW YORK

Wanted—Foreman in chandelier factory. Must have had some experience. Address, stating nationality, age and experience to Box 376, AMERICAN MACHINIST.

Wanted—Experienced foreman for marine engine company building highest grade of two and four cycle engines. Must be up-to-date on shop practice and a hustler, capable of turning out first-class work only. Must be sober and reliable. State salary expected, experience and references. Box 363, AMER. MACHINIST.

OHIO

Wanted—Draftsman to work on the design of metal shapers in Cincinnati. Address "Shaping Machine," care AMERICAN MACHINIST.

Wanted—First-class draftsman who understands design of modern engine lathes. State experience and salary. Address "Lathe," care AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Foreman for modern foundry making engine castings; capacity 20 to 25 tons. A very desirable place for the right man. Box 319, AMERICAN MACHINIST.

Wanted—Toolmaker for jig work and repairs to small tools. Steady work. Experienced in tool room system. Married man preferred. State experience and wages expected. Box 371, AMERICAN MACHINIST.

Wanted—Draftsman; technical man, thoroughly trained on typewriter or adding machine work, for position in main drafting office on new model work. Address Adder Machine Company, Wilkes-Barre, Pa.

Wanted—Draftsman, for position in shop drawing room, on jigs, dies, fixtures, etc. Must be thoroughly experienced in high class small parts manufacturing and capable of designing tools for rapid production. Address The Adder Machine Company, Wilkes-Barre, Pa.

Wanted—Two model makers. Must be thorough mechanics and have had experience on models in up-to-date typewriter or adding machine experimental or model rooms. Address The Adder Machine Co., Wilkes-Barre, Pa.

Wanted—Chief inspector for small parts manufacturing shop. Must be a thorough mechanic, having had previous experience in similar line of work on typewriters, adding machines or registers. Capable of making rigid inspections of parts and finished sections of high class machines and working to variation of .0005. Address The Adder Machine Company, Wilkes-Barre, Penna.

WISCONSIN

Wanted—Foreman for machine shop in Wisconsin, gas engine work, fifty men. Must be hustler as shop is modern, and modern methods of time saving and cost reducing wanted. Man familiar with gas engine or automobile work preferred. Address, stating experience, Box 367, AMERICAN MACHINIST.

For Sale

U. S. patent 815345, variable speed mechanism, for sale. Address "I. K.," care AM. MACH.

For Sale—Manufacturing plant equipped with electric power, machine, boiler, blacksmith, pattern, woodworking shops. Foundry and storage, with machinery, tools and stock, or plant only. Railroad switch in yard. Shipping facilities by rail, lake or canal. Address Box 318, AMERICAN MACHINIST.

Small Tools—A very complete outfit of small tools, including calipers, micrometers, gages, drills, reamers, taps, dies, wrenches, hammers, squares, bevels, lathe tools, as well as an assortment of carpenters' and pipers' tools, suitable for a repair shop, tool room, or foreman. Will sell entire lot or divide as desired. All are of the very best quality, and in good condition, many being entirely new. Address Box 113, Southbridge, Mass

For Sale—Tracings, patterns, jigs and templets for the following size gas and gasolene engines: 1½, 3 and 5 horse-power vertical and 3, 5, 8, 10, 12, 16 and 20 horse-power horizontal; also a number of finished and unfinished engines of the above sizes. All of the above sizes have been in successful operation for several years. This is a splendid opportunity for anyone wishing to build gas and gasolene engines. You can save thousands of dollars in experimental work by purchasing this complete outfit. Shop rights of valuable patents on these engines will be given to purchaser. Box 366, AMERICAN MACHINIST.

Machinery for sale at the Kokomo, Indiana, Works of the Pittsburgh Plate Glass Company. 1 L. H. 30x60 E. P. Allis girder frame Corliss engine, 24′ fly-wheel; 1 L. H. 10x30 E. P. Allis girder frame Corliss engine, 12′ fly-wheel; 1 G. F. Blake 9x20x12 duplex vertical air pump; 1 E. P. Allis vertical surface condenser, 2700 sq.ft.; 1 15x18 high speed piston valve Beck engine; 1 10x18x14 tandem compound self-oiling Fisher automatic engine; 1 14x10x12 Smith-Vaile duplex steam pump; 1 R. H. Rankin & Fritsch 14x20 Tangye frame slide valve engine; 1 L. H. Rankin & Fritsch 14x20 Tangye frame slide valve; 1 13x20 box bed R. H. Mansfield throttling engine; 1 12x20 box bed L. H. Mansfield throttling engine; 7 14x24 Atlas box bed slide valve engines L. H.; 7 14x24 Atlas box bed slide valve engines R. H.; 1 Laidlaw-Dunn-Gordon 14x22x18 duplex air compressor; fly-wheel type air cylinder, unjacketed; 1 Dean Steam Pump Co. 12x7x10 duplex pump, just out of repair shop; 1 6x4x6 Worthington duplex steam pump; 1 Dean Steam Pump Co. 10x6x10 duplex steam pump; 8 Cahall vertical water tube safety boilers, 250 h.p. each. Inquire about above of W. D. Hartupee, 2d Vice Pres., Pittsburgh Plate Glass Co., Frick Building, Pittsburgh, Pa.